PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
H04Q 3/545 // H04Q 11/04

A1

(11) International Publication Number: WO 93/00776

(43) International Publication Date: 7 January 1993 (07.01.93)

(21) International Application Number: PCT/SE92/00429

(22) International Filing Date: 16 June 1992 (16.06.92)

(30) Priority data:
723,166 28 June 1991 (28.06.91) US

(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventors: RAMSTRÖM, Sune ; Tulegatan 28, S-113 53 Stockholm (SE). TÖRNSTRÖM, Johan ; Vallavägen 374, S-136 41 Haninge (SE). Åkerfeldt, Arne ; Taggsvampsvagen 191, S-141 46 Huddinge (SE). BENGTSSON, Lars ; Tornslingan 15, S-142 01 Tråungsund (SE). DOE, Steve ; 26 Juniper Walk, Shoreham-by-Sea, West Sussex BN43 GJE (GB). GUSTAFSSON, Jan ; Videvägen 23, S-141 30 Huddinge (SE). HARALDSON, Svante ; Störtloppsvägen 42, S-126 59 Hägersten (SE). KARI, Lars ; Oxelvägen 6, S-122 35 Enskede (SE). KEMP, Chris ; 149 Waldegrave Road, Brighton, East Sussex BN1 6GJ (GB). LANTTO, Jörgen ; Middagsvägen 14, S-146 00 Tullinge (SE). LINDSTRÖM, Johan ; Birgerjarlsgatan 104:9, S-114 20 Stockholm (SE). NILSSON, Bertil ; Laxholmsbacken 100, S-127 42 Skärholmen (SE). ÖHMAN, Peter ; Mejramgränd 51, S-182 45 Enebyberg (SE). VAN DER MEER, Jan ; Weidebeemd 14, NL-4907 GP Oosterhout (NL). VAN HAL, Paul ; Pr. Bernhardstraat 35, NL-4902 NE Oosterhout (NL).

(74) Agents: LÖVGREN, Tage et al.; Telefonaktiebolaget LM Ericsson, S-126 25 Stockholm (SE).

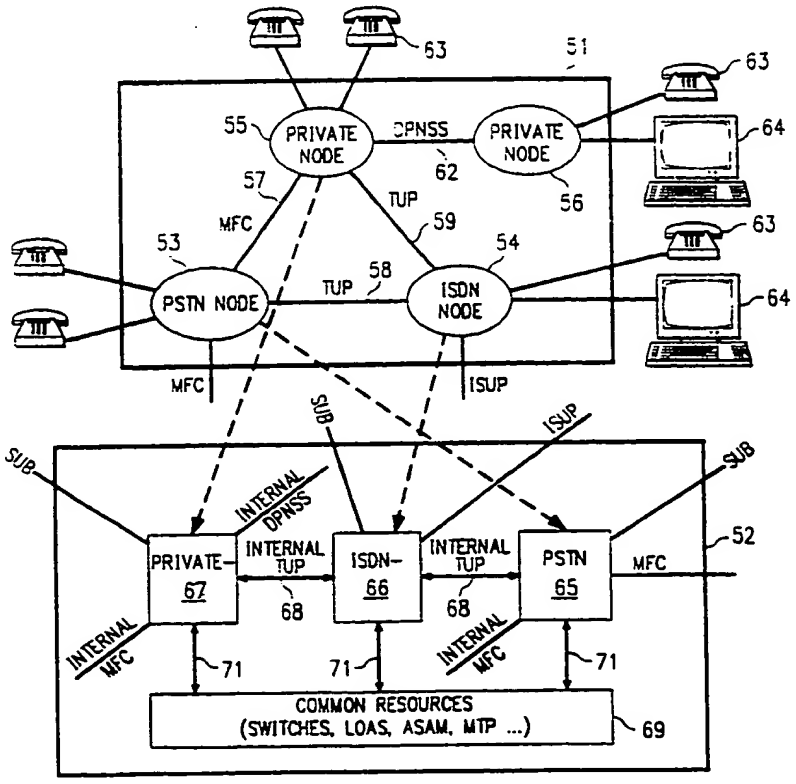
(81) Designated States: AU, BR, CA, FI, JP, KR, NO, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LU, MC, NL, SE).

Published
With international search report.

(54) Title: APPLICATION MODULARITY IN TELECOMMUNICATIONS EXCHANGES

(57) Abstract

A software architecture for use in program controlled telecommunications switching exchanges in which application modules are employed to provide services to users of a particular communications applications. Resource modules provide specific functional elements of communications services to the application modules by having access to and control over the exchange hardware. Network protocols provide communication between the application modules within the exchange and interfaces provide communications between the resource modules and between application modules and resource modules within the exchange.



Best Available Copy

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FI	Finland	ML	Mali
AU	Australia	FR	France	MN	Mongolia
BB	Barbados	GA	Gabon	MR	Mauritania
BE	Belgium	GB	United Kingdom	MW	Malawi
BF	Burkina Faso	GN	Guinea	NL	Netherlands
BG	Bulgaria	GR	Greece	NO	Norway
BJ	Benin	HU	Hungary	PL	Poland
BR	Brazil	IE	Ireland	RO	Romania
CA	Canada	IT	Italy	RU	Russian Federation
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland			SN	Senegal
CI	Côte d'Ivoire	KR	Republic of Korea	SU	Soviet Union
CM	Cameroon	LI	Liechtenstein	TD	Chad
CS	Czechoslovakia	LK	Sri Lanka	TG	Togo
DE	Germany	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		
ES	Spain	MG	Madagascar		

BNSDOCID: <WO 9300776A1>

APPLICATION MODULARITY IN TELECOMMUNICATIONS EXCHANGES

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to telecommunications exchanges and, more particularly, to a software architecture for use in a stored program controlled telecommunications switching system.

History of The Prior Art

In the late 1960s and early 1970s, stored program control (SPC) switching systems were designed primarily around the functions necessary to perform public switched telecommunications network (PSTN) service, that is plain old telephone service (POTS). The SPC telecommunications switches used to render these PSTN services were virtually all designed with a control architecture which separates the parts of the system into functional blocks, each of which perform a separate function in the completion of a call. For example, there are control blocks within a traffic control subsystem of the software which perform digit analysis, route analysis, call supervision, signalling, etc. Each software block performs a certain control function or supervision function within the hardware which contributes to subscriber call setup, supervision, teardown and billing.

Over the years, other special features were added to the POTS services, such as abbreviated dialing, call waiting, and the like, which required the addition of software to the core SPC software operating the switch in order to render these special services.

Stored program control telecommunications switches have evolved over the years into very sophisticated, special purpose, high speed computing machines which include redundant central processors for reliability and remote processors for increased speed and efficiency. A good example of such a switch is the SPC telecommunications switching equipment of the type manufactured by Telefonaktiebolaget L M Ericsson and referred to as the AXE

BNSDOCID: <WO 9300776A1>

exchange, an earlier version of which is disclosed in the article by Mats Eklund, et al., entitled "AXE 10 System Description," published in Ericsson Review, No. 2, 1976, which is hereby incorporated herein by reference. Another example of such an SPC telecommunications switch is disclosed in U.S. Patent No. 4,322,843 to H.J. Beuscher, et al. Such switches usually include all of the hardware necessary to perform a number of different telecommunications services. For example, they can be used as local PSTN exchanges, long distance trunking exchanges, private automatic branch exchanges (PABX), all primarily by the installation of specific SPC software to configure them for the required special functions.

As telecommunications services became more sophisticated over the years, new applications for telecommunications exchanges came into existence which required additional special functionality in the software controlling the switch. For example, the growth of cellular radio telephone services has required switching exchanges to serve as mobile switching centers (MSC) for controlling the interconnection of various radio base site controllers (BSC) and allowing mobile subscribers to be passed from cell to cell within the radio network. Similarly, the advent of integrated services digital network (ISDN) services has also required special functionality within switching exchanges in order to render these services to subscribers. While a number of separate specialized exchanges rendering different services to their respective subscribers can be connected together into a communication network, it is very expensive, both in terms of redundant hardware as well as operation and maintenance personnel to provide discrete switches separately programmed with the functionality required for each type of telecommunication service to be rendered.

One approach to reducing the expenses of a telecommunication network is to provide a plurality of different functions in the same switch. This involves the adding of additional software blocks within the control modules of the switch to provide the required functionality for the rendition of each service. Such functionality may relate to special PSTN related services,

business group or centrex type (PBAX) services, ISDN services, MSC services and others. The problem with such an approach is that while hardware costs are saved by using the same switch for multiple functions, the software, and particularly the interaction of different software blocks with one another, becomes extremely complex. For example, the addition of one new function may adversely affect or even disable the performance of an existing function in a totally unexpected way. As a result, a large part of the software development costs encountered with such systems in use today are connected with trying to anticipate the effect which new code added to the system will have upon the existing code and the testing and debugging of the overall software system in response to the continued addition of new functionality. The evolution of such "megasystems" of software has dramatically increased the costs of adding new upgrades and new functionality to existing services and has increased the development time of such software to the point that new functions are virtually outdated before they can actually be implemented in the switch. These are not desirable results for the telecommunications companies, their customers, or the ultimate subscribers to the services.

Another approach to adding multiple functions to a telecommunications exchange is that of providing multiple processors and dividing out the software to spread it across the several processors. For example, some systems have proposed to have one processor execute certain function blocks of software and another processor execute other function blocks in order to try and decrease the complexity of the software operating within each processor. While multiple processor systems may have some advantages, such as enhanced throughput and call carrying capacity, there are distinct disadvantages with such systems. For example, where there is a chain of functions required for call setup and those functions are spread across multiple processors, a fault in one processor can disrupt the entire call setup process. In addition, the duplication of hardware, such as the use of multiple processors, increases not only the cost of that hardware but also the cost of other ancillary support and main-

tenance functions. These disadvantages of multiprocessor systems are present whether the several processors are in the same switch and located on a common bus or whether they are located in separate switches and interconnected by means of a local area network (LAN).

Still another prior art attempt to achieve multiple functionality in a single telecommunications exchange is to simply load multiple functionally oriented software systems into the same switch and compile them as one such as, for example, the loading of a PABX software system directly into a local PSTN switch. Such a combination includes at least one large disadvantage by requiring physical line circuits to perform the interworking between the PABX part and the local PSTN part. In addition, there may be other conflicts between the functionality of the two different software systems and certainly no cooperative sharing of separately accessed common resources.

Thus, it would be great advantage to organize the software within an SPC telecommunication exchange in a manner which allows multiple specific telecommunications applications to be performed with optimum functionality within the same switch. Such an architecture is provided by the system of the present invention.

SUMMARY OF THE INVENTION

In one aspect, the system of the invention includes separate software blocks defined to include application oriented functions which are associated together in a single exchange serving different applications. The application modules are served by resource modules which provide the necessary communication between different application modules as well as the necessary hardware interactions to perform their respective telecommunications functions.

In one aspect the invention includes a software system for controlling a stored program controlled telecommunications switching exchange which includes a plurality of telecom-

munications control modules. Each control module includes software for implementing a group of features configured to provide telecommunications services for a particular application and without regard to configuration of the features for other applications. The system also includes a plurality of telecommunications resource modules, wherein each resource module includes software for implementing common support services which are useful by two or more of the control modules, and communications links between each of the control modules. The links include network protocols for exchanging information without any control module being aware of whether the control module it is communicating with is in the same exchange.

In a further aspect of the invention the resource modules include a transaction manager for enabling communications between respective ones of said control modules and a connection manager for controlling the hardware of the exchange in response to instructions from the control module.

In a further aspect the present invention includes a software system for controlling a stored program controlled telecommunications exchange in which a plurality of application modules provide telecommunications services to the users connected to the exchange. Each application module include control instructions and data for the implementation of a specific telecommunications application for the users. A plurality of resource modules provide certain functional elements of telecommunications services to each of the application modules. Each resource module has access to and control over the relevant hardware components of the exchange necessary for performing the specific functional actions required to implement its assigned service elements. Data communications is provided between each of the application modules and each other application module and each resource module to enable the telecommunications services of each application module to be provided to the users without use of the control instructions or data of any other application module.

In a still further aspect, the invention includes a plurality of network protocols for structuring the passage of messages between respective application modules so that application modules communicate with other application modules without any knowledge of whether or not the module with which it is communicating is within the same exchange.

BRIEF DESCRIPTION OF THE DRAWINGS

For an understanding of the present invention, and for further objects and advantages thereof, reference may now be had to the following description, taken in conjunction with the accompanying drawings in which:

FIG. 1 is an illustrative characterization of a prior art software system within a local telecommunication exchange;

FIG. 2 is an illustrative characterization of the prior art software within a telecommunication exchange which provides for multiple application functionality;

FIG. 3 is an illustrative characterization of the software within a telecommunication exchange having the architecture configured in accordance with the system of the present invention;

FIG. 4 is a graph illustrating the cost of designing functionality into telecommunications software systems;

FIG. 5 is an illustrative diagram of multiple dedicated telecommunications exchanges interconnected with one another in a network;

FIG. 6 is an illustrative diagram of the way in which multiple application functionality is incorporated into the software system of the present invention;

FIG. 7 is a block diagram of the overall concept embodied in the software system of the present invention;

FIGS. 8 and 9 are block diagrams illustrating communication between two exchanges by means of network protocol signalling;

FIG. 10 is a block diagram illustrating communications between application modules through internal network protocols in accordance with the system of the present invention.

FIG. 11 is a block diagram illustrating certain aspects of a telecommunications network related to the system of the present invention;

FIG. 12 is a block diagram illustrating a service access module as used in the system of the present invention;

FIG. 13 is a block diagram illustrating certain communications aspects of the system of the present invention;

FIG. 14 is a block diagram illustrating certain aspects of communication between different exchanges related to the system of the present invention;

FIG. 15 is a block diagram illustrating communication between different application modules within the same switching system incorporating the system of the present invention;

FIG. 16 is a block diagram illustrating communication between different application modules within different switching systems incorporating the system of the present invention;

FIG. 17 is a block diagram illustrating the functional decomposition of an access application module and a connection manager resource module employed within the system of the present invention;

FIG. 18 is a block diagram illustrating the relationship between line functions within access application modules and different service application modules within the system of the present invention; and

FIG. 19 is a block diagram of access and service application modules and supporting resource modules constructed in accordance with the system of the present invention;

FIG. 20 is a block diagram of an existing application module and a pair of new application modules together with resource modules in a software system constructed in accordance with the present invention;

FIG. 21 is a block diagram illustrating communication between different access and service application modules in the system of the present invention;

FIG. 22 is a block diagram illustrating communication between a pair of application modules through a transaction resource module within the system of the present invention;

FIG. 23 is a block diagram of an existing application module together with a plurality of additional service and access application modules together with resource modules in the system of the present invention;

FIG. 24 is a block diagram of a plurality of hardware and software elements illustrating their interrelationship within the system of the present invention; and

FIG. 25 is a block diagram of application modules and a connection manager resource module within the system of the present invention.

DETAILED DESCRIPTION

General Overview

As discussed above, SPC telecommunications exchanges have evolved dramatically over the last several decades. Initially, there was a limited amount of functionality incorporated into each exchange and the software implementing that functionality was directed primarily to the rendition of PSTN local exchange service. Referring to FIG. 1, there is shown a small house 11 as a metaphor characterizing the software subsystem of a PSTN local exchange well known in the prior art. This software has traditionally been organized into function oriented blocks, each designed to perform a specific functional action and to interact with the other blocks to efficiently provide local public switch telecommunication network services to the subscribers connected to that exchange.

As time went on, a number of new telecommunication services were developed. These services, such as integrated services digital network (ISDN) and public land mobile network (PLMN), required substantially different functionality from that incorporated into the software controlling the traditional PSTN exchange. As metaphorically illustrated in FIG. 2, the addition of ISDN functionality 12 and PLMN functionality 13 to the traditional PSTN software functionality 11 required the addition of numerous braces, props and software fixes 14 necessary to provide the new functionality within the existing framework of conventional PSTN based software architectures. The development of such new functionality and the incorporation of it into the existing structural framework involves a tremendous amount of development time and cost, as well as the compromising of numerous features and functions in order to ensure that all of the functionality

BNSDOCID: <WO 9300776A1>

will work together harmoniously in the same exchange. Moreover, the design of such "megasystems" of software are reaching the point at which the complexity has become so great and the development time so long that this approach is no longer a viable solution to the need for additional telecommunications functions.

The system of the present invention provides a new architectural approach to software structures within existing SPC telecommunication exchange hardware and allows the development of individual application modules for providing functionality for a particular telecommunications application, in a highly efficient functionality. As metaphorically represented in FIG. 3, a PSTN application module 15 may coexist with an ISDN application module 16 and a PLMN application module 17 all within the same hardware and the same application platform 18. The road 19 by which they all communication and interrelate with one another is formed by a plurality of resource modules within the software which enable the respective application modules to communicate with and relate to one another and with respective ones of the resource modules through network protocols. That is, the software within the architecture of the present invention is networked within each exchange in a manner similar to the way in which discrete exchanges are networked with one another, as will be set forth in greater detail below.

Referring to FIG. 4, there is shown a graph illustrating the current cost of development of successive versions of prior art software within a telecommunication exchange. As illustrated, the development costs of one issue of a software package 21 includes a certain initial cost 22 and involve an increasing amount of work as additional functions are added to that software. Ultimately, the cost of adding additional functions becomes so prohibitive that a particular software package reaches its structural breaking point 23 and requires a redesign. Production costs of the next edition of the software 24 involves a certain redesign cost, preferably undertaken at a cost effective time prior to the breaking point of the first software edition 21. As additional functions are added to the next edition of the software 24, it too

BNSDOCID: <WO 9300776A1>

reaches a breaking point 26 and again requires a redesign into a third edition 27 and so forth. As can be seen from FIG. 4, the amount of work, and thus the costs, of adding additional functions to conventional telecommunications software packages becomes more expensive the more complex the software becomes. Eventually, the software becomes so complex that it is no longer modifiable and requires a full redesign in order to continue to perform its functions. The system of the present invention provides an architecture which dramatically simplifies the inherent necessity of upgrading telecommunications software to add new functionality and dramatically decreases the cost of such continued growth and the expansion of telecommunication services.

FIG. 5 illustrates a traditional telecommunications network in which the objects in the network are the exchanges. A local PSTN exchange 31 serves its local subscribers and is connected via trunks 32 to a transit PSTN exchange 33, which is in turn connected to an international gateway PSTN exchange 34. For purposes of illustration, these exchanges 31-34 are located in a first country 35 and are connected to exchanges within a second country 36 by means of international trunks 37 connected to an international PSTN exchange 38. The additional exchanges served by the international PSTN exchange 38 may include a national ISDN exchange 39 as well as a national PSTN exchange 40, each of which include a plurality of subscribers and are connected by means of trunks 41. In addition, the national PSTN 40 exchange may also be connected by trunk 41 to a plurality of private PABX exchange networks 42 and 43 serving their respective subscribers. As illustrated, exchanges of such an international network are coupled together by means of various networks links and communicate with one another by means of network protocols so that they may serve their respective areas by providing communications between their respective subscribers and other subscribers within the network.

Referring next to FIG. 6, there is shown an illustration of the software system of the present invention in which a single exchange 51 can be viewed as incorporating a plurality of separate logical nodes and the functionality of those nodes and the

interconnections between them is incorporated into a single exchange 52 containing the software system of the present invention. For example, a local PSTN node 53 may be connected to an ISDN node 54, both of which are coupled to a private business group node 55 which is in turn coupled to another private business group node 56. The local PSTN node 53 communicates with the business group node 55 through a multifrequency code (MFC) protocol 57, while the ISDN node 54 communicates with both the local PSTN node 53 and the private business group node 55 through the CCITT telephone user part (TUP) protocols 58 and 59. The ISDN node 54 may communicate with other ISDN nodes via an integrated services user part (ISUP) protocol 61 and the private node 56 communicates with the private node 55 via a digital private network signalling system protocol (DPNSS) 62. Each of the separate nodes 53-56 include telephone subscribers 63 while the private business group node 56 and the ISDN node 54 may also include data communications subscribers 64. The way in which each of these nodes communicate with other nodes via certain defined protocols is reflected in the software architecture of the present invention which incorporates within a single switch 52 the functionality of the local PSTN node 53 by including a PSTN application module 65. Similarly, the functionality of the ISDN node 54 is incorporated into an ISDN application module 66 while the functionality of the private business group node 55 is incorporated into a business group application module 67, each of which may communicate with one another via a defined TUP protocol 68 and with a plurality of common resources 69 via defined interfaces 71. The common resources 69 may include switches, load supervision (LOAS), announcement machines (ASAM), message transfer parts (MTP) and others. As can be seen in FIG. 6, incorporating the functionality within discrete application modules in the same switch 52 allows great advantages in the simplification of the software into specific application functions. In the system of the present invention, networking within the software is performed in a similar manner inside the switch 52 as outside the exchange.

Referring to FIG. 7, there is shown a block diagram of the components of the software system of the present invention 72 which comprises a plurality of individual application modules 73 which are interconnected and coupled both with one another and with a plurality of resource modules 74. The application modules (AMs) 73 communicate with one another and with the resource modules (RMs) by means of defined protocols 75 between AMs 73 and defined interfaces with RMs 74 which, in effect, create virtual switches and enable interaction and networking of the software in a manner which permits the efficient implementation of discrete telecommunication application oriented blocks. This architecture provides great advantages in the implementation of the software by allowing the tailoring of each application module to the individual functionality associated with a particular telecommunications application. For example, the functionality of the software necessary to implement a business group communications application is substantially different to that necessary to implement an ISDN application. Dividing the software into application oriented modules enables the providing of discrete telecommunications functions custom configured for particular applications without the necessity of one application's software interacting with software directed to an entirely different application functionality, as in the case of the present software structures within a single telecommunications exchange. Each of the application modules can readily communicate with one another and may draw upon resource modules within the software which provide all necessary interactions with the switch hardware and with certain functional services which are available to the individual application modules and are common to more than one of the application modules. In effect, each application module comprises a virtual switch or a virtual exchange which thinks that it owns the switch hardware and is free to utilize that hardware exclusively for its own distinct application oriented functionality. This architecture allows the addition of upgrades to the software and enhancement of the functionality of one application module without regard to the affect of those software changes on other application modules. Since the exchange is no longer controlled by a single body of functionally divided blocks, there

BNSDOCID: <WO 9300776A1>

is much less likelihood that modifying a functional feature for one application will adversely affect the performance of that function in another application.

Application Module Network Specification

General Principles

When specifying the upper or service level of any application module, such as that of a business communication group, the services are described as they are seen from outside the system. The network level is, however, directed to the services as they are seen within the application module itself. Two basic principals which should be observed are:

I A service should appear identical to the user regardless of whether the other users involved in the service are on the same or other nodes in the network; and

II The user must be able to move from one node to another without the necessity of changing the user's number.

On the network level, the services to be provided are considered in terms of the demands they place on the network. Moreover, the network level is concerned with the allocation of functionality within the network and such issues as centralized or distributed control within the network.

In general, the first step is to consider how a telecommunications application is specified, which may include specification as a development of an already specified service network, e.g., PSTN, or as a separate service network, e.g., ISDN, as specified by C.C.I.T.T. The second step is to identify a reference model for the service network, i.e., nodes with specified reference points in between, e.g., access and transit nodes with specified protocols as reference points. This reference model for a service network will form the base for structuring of the system into AMs. In reference models for the nodes, common functionality is identified and will form the basis for structuring the system into RMs.

The Network Model

In general, a network can be seen as a number of nodes connected together by links. In a telecommunications network, the nodes are telephone exchanges, subscribers and other peripheral equipment, such as computer databases. Traditionally, the controlling nodes in a network have been designed to fulfill specific roles, such as local exchanges, transit exchanges, mobile subscriber exchanges and the like. However, more and more exchange nodes are being asked to fulfill more than one role at the same time. This has often caused problems in design due to the interaction of the different requirements for each role. This is especially true with centrex business group communication functions where there is a need to see a centrex group as a separate PABX, which is isolated from the public switching functions of the system.

There are telecommunications administrations that specify business communications services as a separate service network. The reference model for business communications consists of access nodes and service nodes. These form the basis for identification of the business group AM, the analog access AM, and the digital access AM.

If we consider the nodes we wish to implement in a network as logical elements rather than physical elements, it can provide a more flexible solution to the problems. Each logical element can be seen as a component in an application of which the business group application module is merely one example. Other examples include the PSTN node, MSC node, etc., and each application supports a number of already defined interfaces, such as MFC, C7, DASS1, DPNSS, R2, etc., each of which can be used to interconnect different application modules, both internally and externally within the physical exchange. Such a logical node oriented structure allows the definition and development of application modules separately from one another by using defined interfaces.

It has been suggested that basic telecommunications features should be able to be used in any application; however, each application has its own distinctive nuances and requirements for

each basic feature because of the nature of the communication services to be provided. For example, the call diversion feature has different specific requirements when implemented for PSTN services, business group services, mobile services, and ISDN services. Thus, if there was only one call diversion feature within the system, it would be affected by the addition of each new application to the system.

In accordance with the system of the present invention, each application can be designed in the most suitable way with basic features adapted to that particular application. Each application would be a functionally modular unit that can be freely combined in one exchange with any number of other applications. In the network model, an instance of an application module is called a logical node. The logical nodes are all linked together to form a logical network.

The network model provides the opportunity to functionally decompose the telecommunication applications for complex services into several simple application modules. Each module can be designed apart from the others and there is no need to be concerned about the interactions with other modules or the internal workings of the other modules. Once objects have been implemented in accordance with such networking principles, all services will function identically regardless of whether subscribers involved are located in the same or in separate nodes and network transparency of services will have been achieved.

In applying these principles to the business group services, as an exemplary application module, a subscriber does not want to be concerned with implementation problems. Implementing networks by means of exchanges connected together via links rather than by one single exchange should not be allowed to degrade the service provided. When a call is to be established, the system will be informed of the desired destination of the calls by means of a string of digits referred to as a directory number. A directory number should identify the desired user, not be associated with a special item of user equipment. The subscriber defines the

numbering plan to be used within the business group and the allocation of internal directory numbers is entirely under the subscriber's control. However, for calls outside the business group, the directory number must conform to external convention and/or standards and the number plan must also allow for the invocation of services and facilities solely by dialing/keying digits without ambiguity.

The generic system level architecture for each application module in an exchange, arranged in accordance with the system of the present invention, including the exemplary business group being discussed herein, employs the shared use of resource modules. The access application modules own the line access hardware along with some software associated with the interface. They have no knowledge or understanding of any of the services supported. The resource modules supply general support facilities for all the application modules in the exchange. The transaction manager resource module provides common facilities to all application modules to assist in the transport of messages. It establishes links between software components in different application modules. The connection resource module owns the switching hardware and other pooled resources such as tone receivers, multijunctures and the like, which enables the application modules to use those resources and resolves any conflicts and demands for the same connection or resource. Other resource modules, such as charging support, operation and maintenance support, analysis support, time supervision support, and the like, will also be employed in assistance of the application modules. The resource modules in the present system can be seen as a set of tools wherein each application module selects and uses what is needed from the tool box for its specific telecommunication application. The resource modules are accessed through their interfaces which are strictly backwards compatible. The resource modules provide a platform to support the design of telecommunications applications, i.e., the application modules. The different components of both the application modules and resource modules are implemented in software blocks.

Network Communications

Since the provision of a telecommunications service necessarily involves more than one object, it is necessary to consider how the different objects communicate with one another. Such communication is accomplished by means of protocols.

There are basically three types of communication protocols within the architecture:

I Intra-network communication protocols;

II Internal protocols;

III Inter-network communication protocols.

The intra-network protocols involve communication between intelligent objects forming part of the same network. Protocol use is needed to support all the services provided by its network type. The information to be carried between application modules includes all of the information that has to be carried between separate nodes of the same network type. Therefore, the protocol used between application modules is a superset of the protocol defined for use between nodes, for example, the lower levels will follow the Q900 series recommendations. Since there is currently no agreed international standards for the networking of business group services as standard, such as the open U.K. DPNSS standard of information, flow can be used in such instances.

The purpose of the internal protocols is to communicate between all which objects required in order to support the telephony services. Such protocols should be capable of conveying:

I information elements of only internal significance, e.g., connection reference point;

II information elements needed to support a basic telephony service; and

III envelopes for information elements of significance only to particularly sophisticated signalling systems.

The inter-network communication network protocol comprises standard digital protocols used in telecommunication systems. Those such as telephone user part (TUP), integrated services user part (ISUP), national user part (NUP), etc. can be employed as

they are currently used between nodes of a telecommunication network today comprising separate switches. A gateway service module is used for each type of application module and communicates with the application network for the other network types via transaction support.

Software Module Communications

An important aspect of the system of the present invention is the provision of effective communications between the various software modules. The communications between application modules is network oriented while the communications between application modules and resource modules is system oriented. The network oriented communications is in the form of protocols which are specific and well defined rules for controlling information transfer between systems, such as telephone exchanges. Protocols are made up of sequences of messages with specific formats and meanings, e. g., TUP, MFCR2, TCAP, etc. FIGS. 8 and 9 illustrate communications between a pair of exchanges according to the CCITT signal system no. 7 telephony user part (TUP) signaling protocol. FIG. 9 shows that the message transfer part (MTP) corresponds to approximately layers 1-3 and that the user part (UP) represents the remaining layers 4-7. Examples of user parts include telephony user part (TUP), integrated services digital network user part (ISDN UP), etc. A protocol that can communicate with other exchanges is documented in the form of a protocol description (PD) which describes all layers 1-7, e.g., which MTP (e.g., as exemplified in the yellow and red books of the C.C.I.T.T.), the format of messages in the user part, coding of information fields, procedures, etc.

As discussed above, numerous ones of the existing network protocols may provide communications between application modules in accordance with the system of the present invention. Set forth below is a list containing illustrative representative protocols which may be employed in particular embodiments of the present system along with a reference to the C.C.I.T.T. documentation thereof which is hereby incorporated by reference herein.

PROTOCOL	C.C.I.T.T. RECOMMENDATION NO.
MFC-R2	Q.310-Q.490
TUP	Q.72X
ISUP	Q.76X
D-CHANNEL	Q.93X (LAYER 2:Q.92X)
TCAP+SCCP	Q.771-Q.795
CCITT NO. 7	Q.700-Q.716
CCITT NO. 6	Q.251-Q.300

To illustrate how signalling is performed in an exchange structured according to the application modularity concept, FIG. 10 shows a call going through such an exchange. The application module to application module protocol illustrated in exchange B of FIG. 10 is an internal type of protocol, i.e., one which is only used for communication between application modules located in the same exchange. Instead of using the message transfer part (MTP) as an end-to-end carrier for layers 1-3, the application module protocol makes use of the services offered by the transaction manager resource module included within the system of the present invention. The application module to application module protocol is documented and provides specific formats of messages, coding of information fields, and other procedures which are specific to that protocol covering layers 4-7. Within these protocols there may be a number of specific and different application module to application module protocols.

The differences between an "external" protocol functional specification, e.g., ISUP, and a "internal" protocol functional specification, e.g., NIIP, include the following:

1. An external protocol is required to carry the data concerning the physical resources involved, e.g., PCM channels, and how those resources are tied to the calls. This requires that operation and maintenance procedures and messages are included in order to handle these resources, e.g., blocking, etc. Such is not the case for internal protocols, as there are no physical resources being used, only logical circuits.
2. The length of messages, message structures and coding of information may differ between internal and external protocols

since they are using different carriers for the layers 1-3, i.e., the MTP services or the transaction services.

3. Internal protocols may require additional information regarding, for example, session references for charging output, logic circuit references, etc., that are not required within an external protocol.

Some of the common elements between external and internal protocols is that both should be able to satisfy the following:

1. Both should handle "hostile" environments since things occasionally go wrong and messages disappear and, therefore, require timers to guard against this possibility;

2. Both should not reflect the internal structure of the application modules or the structure of particular manufacturers' hardware;

3. Neither should assume a specific user of the protocol; and

4. Both should be "complete" in that they cover all layers 1-7.

The application module to resource module communication is structured in the form of a system interface seen from the application module's point of view, i.e., both elements of the communication are contained within the same environment, i.e., within a common control system. Application module protocols are peer-to-peer communication, while application module to resource module interfaces are client to server oriented. The user interface to a resource module may consist of PLEX signals and the interface is described in an interface specification. A resource module has an identical interface to all AMs/RMs which does not allow any unique signals to be sent from an RM. In order to perform a service one RM can call upon the services of other RMs. FIG. 10 illustrates an example of an application module using the interface, and therefore, the services from a transaction manager resource module. The following points should be observed when structuring the layout/look of the resource module interfaces:

(a) Geographical distribution is not a factor to be considered since the resource modules can only be accessed within the same system;

(b) Different manufacturers of equipment are not a factor to be considered since the resource modules are all contained within a single system;

(c) Different users are a factor to be considered in that resource modules are used by different application modules and offer different physical services to those application modules; and

(d) A client/server relationship should be maintained between the communication with the resource modules.

In documenting the interfaces to be used within the system of the present invention, such interfaces can be specified by software signals comprising the messages and coding information. Each resource module may offer a number of different services, there may be a number of different interfaces. For example, the current design rules in the message transfer parts of conventional protocols are good examples of such application module/resource module interfaces. Thus, such interfaces can then be specified along with the number of software signals needed to perform the service offered by the resource module. One such interface may include the current design rules for using the message transfer part services within the common channel signalling subsystem (CCS) of the AXE-10 SPC switching system.

Access Structure Within Application Module Networks

The term "access" is used herein for the means needed by a user to reach the user services that are subscribed to in the communications system. The following discussion will identify these means in the form of components or functional entities using an object oriented approach. Such an approach supports rapid development in the required accesses by allowing a clear separation between technology and functionality, between access and user services, and between traffic handling and operations and maintenance. The components identified define an access object structure which can be used as a base when defining the access product structure.

In the access area of the present system there are two access application modules, an analog access application module (AAM) and a digital access application module (IAM). In structuring the access within the present system certain basic principles are followed:

1. Access and user services are separated and, thus, no subscriber knowledge, subscriber data or user services are part of the access application modules.

2. Physical distribution of the access application modules is enabled by a network protocol between the access application modules and the service application modules.

3. Physical distribution of switches within the same switching system is hidden from the switch users. This is achieved by defining a communications interface to a connection manager resource module which governs the different switches in the switching system.

4. Functionality and technology are separated from one another. That is, technology, i.e., the low layer (OSI layer 1-2) functionality is independent of the high level functionality, such as user services implemented in the telecommunications network, by defining low layer protocols carrying no high level knowledge. This enables reuse of the technology by a variety of high level functionality.

Referring now to FIG. 11, it is illustrated that a telecom network 200 includes a number of distinct functional units in order to perform its intended purpose. In order to perform a telecommunication service for a user the network 200 includes an access component 201, a user service entity (USE) 202 and a network service entity (NSE) 203. The user may include either a human being, an application program or other users which seek to make use of the user services that are subscribed to within the telecom network 200. The access 201 provides the means needed by the user to reach the user services which are subscribed to. The user service entity 202 offers and executes services to the user that are being subscribed to by handling service interactions, charges to the entity that has subscribed to the services and the like. The network service entity 203 provides information transfer

capability and services, for example, provides bearer service and capabilities as described by the CCITT in recommendation I.210.

Referring next to FIG. 12, there is shown how the service access that the service application module 204 employs in the system of the present invention includes the user service entity 202 as well as the network service entity 203. The service application module 204 is in turn accessed by the user through an access application module 201. FIG. 13 shows the different physical access products on a switching network level and illustrates that users may access a switch 205 within a switching system 206 either directly via the centrally located subscriber switch (SSS) 207 or remotely through a remote subscriber switch 208 and a transmission network 209. FIG. 14 illustrates that a user may access any number of versions of switches 206a-206c within a switching system 206 through a transmission network 209 employing standard protocols via an independent access product 210, such as an access multiplex concentrator (AMC). Such a product 210 is in itself a homogeneous switching system that can serve other homogeneous switches systems with access services on a switching network level regardless of which of the particular switching systems 206a-206c is being accessed.

One reason for having a network protocol to the access application modules 204a and 204b is that it will enable physical distribution of terminal equipment and lines in the switching network. In this way, the access application module can be mapped upon a physical access product in another switching system than the user service entity, as shown in FIGS. 15 and 16. In FIG. 15, a switching network 201 includes a switching system 206 comprising an analog access application module/digital access application module 226/227 in communication with the user service entity 202 of a service application module 204 via a network protocol 229. Similarly, in FIG. 16, a switching network 201 includes two switching systems 206a and 206b, one of which includes the analog access application module/digital access application module 226/227, while the other includes the user service entity 204 within the service application module 204. In this circumstance,

BNSDOCID: <WO 9300776A1>

the access module 226/227 communicates with the user service entity in the service application module 204 by means of the same network protocol 229, this time connected through a transmission network 209 rather than directly between the application modules themselves. Both switching systems 206a and 206b would also include interfaces toward the intermediate transmission network 209 in order to implement the network protocol 229 and communicate therethrough.

Referring next to FIG. 17, there is shown a functional decomposition of the analog/digital access application module as well as the decompositions of the line entrance (LE) 231 and a connection manager 145, illustrating their close relationship to one another. As illustrated, the analog/digital access application module 226/227 includes a line entrance (LE) 231 and a line handler (LH) 232. The line entrance 231 comprises a main distribution frame/automatic cross connect (MDF/ACC) 233, as well as a line terminal (LT) 234 and a signalling terminal (ST) 235. A connection manager resource module 145, for example, including access to a time switch 156g, a remote terminal/juncture terminal 156h, a group switch 156j and other hardware 156k, provides connection services to both the line handler 232 and to the service application module 204. The line entrance 231 provides the physical medium that connects the system line 229 to the analog access application module/digital access application module 226/227. This physical medium handles the conversion between the electrical values on the line/system line 229 and the internal representation (electrical/logical) in the switching system itself. It also subtracts and supports the signalling part in the TE/RT interface. That is, it handles roughly layers 1 and 2 in the OSI protocol for the communication with the TE/RT. The functionality of the line entrance 231 is implemented in the MDF/ACC 223, the LT 234 (which handles roughly the OSI layer 1) and the ST 235 (which handles roughly OSI layer 2). The line handler 232 provides the means needed for the line entrance 231 to reach the user services in the user service entity 202 of the service application module 204. It coordinates signalling and line handling activities such as seizure of lines and line channels,

BNSDOCID: <WO 9300776A1>

and also orders the connection manager 145 to set up signalling connections between the line terminals 234 and signalling terminals 235. The connection manager 145 handles the physical connection, i.e., the paths, in the switching system and in the process of conducting these activities, handles the various switch components such as the time switch 156g, the remote terminal/juncture terminal 156h, the group switch 156j and others. In the access application module 226/227, low layer protocols are defined to the line entrance 231 with respect to line terminals 234 and signalling terminals 235. In this sense, the line entrance 231 clearly is a candidate to be implemented as a resource module. In such cases, for example, market variations would affect mainly the line handler 232. For the connection manager, low layer protocols should be defined to the different switches used, for example, to the time switch 156g and group switch 156j. In general, the technology, i.e., the low layer OSI, layer 1-2, functionality should be independent of high level functionality such as user services implemented in the telecommunication network. Technology could be separated from the high level functionality through defining low layer protocols (LLP) carrying no high level knowledge. These low layer protocols would only be affected by changes in technology and, in this way, the same technology could be reused by a variety of high level functionality. Lower level protocols 236 are used between the line entrance 231 and the line handler 236 as well as between the connection manager 145 and the respective switch elements 156.

Referring next to FIG. 18, one of the main tasks for the line handler 232 within each of the analog access application modules 226 and digital access application modules 227 is to provide the means for lines 215a-215g and terminal equipment 213a-213g to reach the user services in appropriate user service entities 202a-202d within the respective service application modules 121-125. In principal, each piece of terminal equipment 213a-213g may be connected to different user service entities 202a-202d which means that the line handlers 232 must be able to read messages on a line and terminal equipment basis. In addition, the required channel within the line may be indicated, which means that the semantics

of the network protocols between the access application modules 226 and 227 and the user service entities, the line, terminal equipment and the channel within the line are needed as keys, as illustrated in FIG. 18. It is up to the user service entities 202a-202d to reject user services not supported by the network protocol to a specific line. For example, each type of access could have the possible user categories defined in the user service entities 202a-202d.

Referring next to FIG. 19, there is shown a block diagram illustrating an architectural overview of the way in which an exemplary service application module, such as a business group (BG) application module 123, interfaces with other application modules and resource modules within the resource module platform 104 in order to complete a call between two users within a business group. Within the business group application module 123, each call will normally involve three object instances of the user or trunk service entity types (USE or TSE) 135 and 136, one for each of the two sides of the call. These two instances, 135 and 136, are linked by an instance of the network service entity (NSE) 137. In addition, a number of facilities provided by resource modules and accesses will be employed in interfaces with the business group application module 123. For example, the A party user 138 will be linked to the BG module 123 by either a digital access application module (IAM) 139 or an analog access application module (AAM) 141, while the B party user 142 will also be linked to the BG application module 123 by means of a digital access application module 143 or an analog application module 144. Each of the service entities 135-137 are connected with a plurality of different resource modules located within the resource module platform 104. For example, the connection manager resource module 145, the transaction manager resource module 146 and other support manager resource modules 147 provide the necessary support services for the user and network service entities 135-137. Similarly, the connection and transaction resource modules 145 and 146 are interfaced with analog access resource modules 148 and digital access resource modules 149.

BNSDOCID: <WO 9300776A1>

Within the business group application module 123, the user service entity 135 or 136 includes a user agent which communicates with the user via the access application modules 139-144, which control the hardware interfaces linked to the user's telecommunication equipment. The user agent of the user service entity includes the logic for providing the user's services. Similarly, the trunk service entity 135 or 136 includes the logical functions for controlling intra-network links. It controls the trunks via the trunk line entrances which control the hardware interfaces to those trunks. The various line entrances are used to provide a variety of interface related functions.

The network service entity 137 is an object type which exists to link, for example, two instances of user service entity or trunk service entity types in a simple call. It connects to any of them with the same standard protocol which maps simply into the inter-exchange protocol. The user service entity instances originating and terminating a call have the same interface to the network service entity (NSE) regardless of whether they are on the same or separate exchanges. This ensures that services will work in the same way across a network as across an individual exchange. The resource modules 145-147 provide standard transaction and connection management functions. The transaction manager resource module 146 is optional for communication between service entities 135-137 and mandatory between separate application modules and between application modules and accesses 148-149.

While FIG. 19 illustrates a call taking place between two users or trunks within the business group application module, similar entities are necessary in calls to be completed between a business group application module and another different application module, for example, the PSTN application module 122. In such a situation, an additional entity not specifically shown in FIG. 19, and referred to as a gateway services entity (GSE), is required and this object type provides gateways to other network types. Its primary concern is with conversion from the internal protocol within the application module, to the protocol needed to access

the other application types. It would also be concerned with interworking and charging as a result of this interconnection.

Referring next to FIG. 20, here is shown an additional overview of the system architecture of the present invention which includes a plurality of application modules, 122-125, and a plurality of resource modules 145-149. The application modules 122-125 contain the application's specific functionality, such as user services, traffic handling and routing. Since each traffic handling application module supports a simple call protocol, these modules are portable between different markets. For example, an application module designed for a business group in one country can be introduced into an exchange in any other market without the need for any additional design effort. Such modularity allows very fast introduction of existing applications into additional markets as they are needed. The resource modules 145-149 provide the system common functions, such as call signalling distribution between application modules, provided by transaction manager 146, switch handling and coordination, provided by the connection manager 145, and charging data collection and output, provided by the charging manager 147. In addition, the resource modules 145-149 provide tools for common routines to aid in the design of application modules. The nature of the resource modules 145-149 is such that they provide a good base for the design of network services along with the reduction of service interactions. The subscriber line entrance 151, and trunk line entrance 152, form part of both the connection manager resource module 145 and transaction manager resource module 146, and provide the interfaces to the outside world as well as the hardware and line supervision functions. They do not contain any applications specific or traffic handling functions. This structure not only provides a base for reducing the complexity of the application modules and the coordination of functionality between them, but also a good base for the introduction of new system concepts within the software.

As also illustrated in FIG. 20, the system of the present invention allows immediate reuse of existing application modules, such

BNSDOCID: <WO 9300776A1>

as an existing PSTN application 122. For example, a present PSTN function providing software system such as the APT 210 08 used in the Ericsson AXE exchanges, can be combined with new application modules 123 and 125. New system solutions have been thought of in the past to be problems of function change, improved restart handling and the like; however, the introduction of such new system solutions has commonly been rejected due to the need to rewrite the majority of the existing software in the system in order to implement them. With the present application modularity concept, new applications can have such facilities from the outset without the need to change existing software. The introduction of new application modules is rendered much easier due to the split between the pure software application modules and the hardware owning resource modules. This is due to the fact that it is most often the hardware owning software that causes the greatest obstacles to the introduction of new system concepts.

As exemplified in FIG. 20, new application modules 123 and 125 can provide entirely new solutions in functionality alongside existing solutions such as the PSTN application module 122. This, in effect, means that new technologies can be introduced constantly without the need to redesign previously designed application modules. For example, a version of forlopp restart may be included within each of the new application modules 123 and 125 so that a fault detected within these modules that would normally require an entire system restart can be isolated to affect only the call or command to which it relates. If such action is not enough to clear the fault, then all the software within the one particular application module can be restarted and only if both these actions failed would an entire system restart be required. Such new functionality can now be applied within each individual new application module and the affect of software faults on exchange performance will be greatly reduced. Similarly, new application modules, such as BG module 123 and ISDN module 125, can be designed in such a way that there is no need to disturb any existing call, either while it is in speech or being set up, while making a function change. In general, at the time of function change, all calls that have already been initiated will be handled

by the old application module software and subsequent calls by the new application module software and, in effect, both application modules will be working in parallel for a short period of time. In addition, as the hardware is separated from the software of the application modules, it is possible to detect if a device has been left hanging. Such devices can then be released automatically and the application software can be reset using forlopp restart principles referred to above.

Referring now to FIG. 21, there is shown a diagram illustrating the manner in which the transaction resource module 146 provides message transfer capability between respective ones of the service application modules 122 and 123 and the access application modules 141 and 144. The transaction resource module 146 includes the necessary protocols 130 to enable different application modules to communicate with one another.

Referring to FIG. 22, the message transfer capability of the transaction resource module 146 is illustrated more specifically through its role of providing communication between a first application module 122 and a second application module 123. One function of the transaction resource module 146 is to hide the physical location and type of cooperating application modules from one another. From either of the two application modules 122 and 123, all messages are addressed employing a transaction reference 140 which is translated by the transaction resource module 146 into the address of the cooperating application module for which the communication is intended. If the two cooperating application modules 122 and 123 are located in separate exchanges, then the inter-application module messages are passed via trunk line entrances to a physical signalling channel connecting the two exchanges to one another. In either case, the message sequences and message handling is identical whether the two application modules 122 and 123 are in the same exchange or not. The transaction protocols preferably include a two-layer structure. The lower layer is a generic session protocol that sets up and clears down calls between application modules which is then used to carry the upper layer or application protocol, which may be analogous to

BNSDOCID: <WO 9300776A1>

the subsignalling (SS), telephone user part (TUP), integrated services user part (ISUP), or mobile application part (MAP) protocols. This means that the seizing of records, i.e., instance handling, and basic call handling states can be separated from one another. In general, access application modules are designed to have as little functional influence on traffic handling as possible. In principle, they are transparent and simply convert the external physical signalling interface into an internal and easier to manage form. They do not, however, take care of additional maintenance functions and the time required when physical interfaces are used. Referring next to FIG. 23, there is shown a block diagram of a plurality of service access application modules 121-126, and access application modules 139-144, along with a plurality of resource application modules 145-147 and 150. As illustrated, an existing PSTN application 122 could be readily combined with newly designed application modules such as the business group module 123. Functionally speaking, the service application modules 121-126 provide certain functions uniquely configured to their own individual applications for which they are provided. For example, their functionality may include digit analysis, routing, and unique telecommunications services which are specifically configured for the particular telecommunications application for which they are designed. Each of the access application modules 139-144 provide access functionality within the system and includes functionality such as protocol analysis, hardware maintenance, and line maintenance.

The resource modules illustrated in FIG. 23 include the connection manager 145, the transaction manager 146, a charging resource manager 147, and an input/output (I/O) manager 150, as examples of resource modules. Each of these resource modules provide functions which are common to one or more application modules and which enable those application modules to provide telecommunication service in accordance with the particular application for which they were designed. For example, the connection manager may provide connection coordination, and interface with both the group switch and the subscriber switch, switch maintenance functions, as well as multi-junctures (MJS), as well as key

receivers/code receivers/code senders (KR/CR/CS). In addition, the connection manager 145 provides access to announcement machines as well as tone generators and internetworking units (IWUS). As discussed above, the transaction manager 146 provides interfaces between different application modules and enables communication between them. The charging manager 147 provides services to the application modules connected with the charging of calls in a manner related to common charging elements to each of the application modules. In addition, the I/O manager 150 facilitates input/output functions within both the resource modules and the application modules. It should be understood that the resource modules may call upon the functionality contained within the service application modules to provide their own support functions. For example, an announcement machine resource module may provide its services by calling out through a PSTN application module to reach the physical announcement machine hardware located in a different place from the exchange controlling that resource module. This may apply to other resource modules and resources. Referring now to FIG. 24, there is shown a block diagram illustrating the manner in which the connection manager resource module 145 functions to provide access to all switching functions within the system. That is, service application modules 122 and 123 and access modules 139 and 141 and line entrances 148 interface through logical switch objects 154a-154e within the connection coordination portion 155 of the connection manager resource module 145. These logical switch objects coordinate the connection with the actual switch hardware 156, including time switches (TS), group switches (GS), remote terminals (RT) and juncture terminals (JT). The switch hardware 156 comprises the standard units now present within SPC telecommunication switches, including, for example, key set receivers (KR) 156a, code senders (CS) 156b, code receivers (CR) 156c, digital multi-juncture (DMJ) 156d, announcement machines (ASAM) 156e and internetworking units (IWU) 156f, each of which is owned by the connection manager resource module 145, which interfaces with the line entrance hardware 153 and 154 in coordination with the access application modules 139 and 141 to provide functional communication. As can be seen, in order to allow each application

BNSDOCID: <WO 9300776A1>

module to control connections without the need to coordinate between themselves, each application module is given its own logical switch objects 145a-145e to control. In order to achieve a complete connection in the real switch, these logical switch objects 154a-154e are linked together via their inlets and outlets to provide a picture of the complete speech path. From this picture, the real, i.e., physical inlets and outlets can be located and these are then connected together using the normal subscriber and group switch elements owned by the connection manager resource module 145. Each logical switch object 154a-154e is designed for a specific purpose and thus has a dedicated interface which means that operations on it are optimized. For most calls, only the access application modules will use logical switches for connecting and disconnecting code receivers and senders. The service providing application module only use simple connection objects that perform no real function, but can be easily replaced by more complex connection objects, for example, conferencing and monitoring if such is required.

Referring next to FIG. 25, there is shown a group of application modules 122-125, together with a number of representative resource modules which may form one embodiment of the system of the present invention. For example, the connection manager resource module 145 and transaction manager resource module 146 form part of the resource module array by providing the essential functions of communication and connection between and with the application modules 122-125. The subscriber line entrance 151 and trunk line entrance 152 are associated with each of the connection resource module 145 and transaction resource module 146. In addition, there is shown a charging manager resource module 147 which performs charging functions which are common to two or more of the application modules. An I/O manager resource module 150 provides input/output functions while a statistics manager resource module 157 provides traffic recording and other statistics measurement and management functions. An application module function code manager 158 provides function code management, while a forlopp manager 159 provides forlopp restart functions necessary within any of the application modules or within the system as a whole if

necessary. An operation and maintenance manager 161 provides the traditional operation and maintenance functions. A subscriber data manager 162 manages data associated with individual subscribers which are common to two or more application modules, including a subscriber number manager 165 and a subscriber service manager 166. A time event manager 163 provides services associated with the monitoring of certain time oriented functions within the system while a route manager 164 provides network route management functions. Manager 167 represents numerous other functions, such as sending/receiving messages by employing particular types of signaling, load management, and output information management, which could be incorporated within resource modules as necessary to provide the service functions to two or more application modules.

As can be seen from the above description of the application modularity architecture of the present invention, the present system proposes numerous advantages and features enabling the efficacious growth of future communication services.

It is thus believed that the operation and construction of the present invention will be apparent from the foregoing description. While the method, apparatus and system shown and described has been characterized as being preferred, it will be obvious that various changes and modification scan be made therein without departing from the spirit and scope of the invention as defined in the following claims.

WHAT IS CLAIMED IS:

1. In a stored program controlled telecommunications switching exchange, a software system for controlling said exchange comprising:

a plurality of telecommunications control modules, each control module including software for implementing a group of features configured to provide telecommunications services for a particular application and without regard to configuration of the features for other applications;

a plurality of telecommunications resource modules, each resource module including software for implementing common support services which are useful by two or more of said control modules; and

means for providing communications links between each of said control modules, said links including network protocols for exchanging information without any control module being aware of whether the control module it is communicating with is in the same exchange.

2. In a stored program controlled telecommunications switching exchange, a software system for controlling said exchange as set forth in claim 1 which also includes:

means for providing communications links between each of said control modules and said resource modules, said links including interfaces for exchanging information therebetween.

3. In a stored program controlled telecommunications switching exchange, a software system for controlling said exchange as set forth in claim 2 which also includes:

means for providing communications links between each of said resource modules, said links including interfaces for exchanging information therebetween.

4. In a stored program controlled telecommunications switching exchange, a software system for controlling said exchange as set forth in claim 1 in which said plurality of resource modules include:

a transaction manager for enabling communications between respective ones of said control modules; and

a connection manager for controlling selected hardware of the exchange in response to instructions from said control modules.

5. In a stored program controlled telecommunications switching exchange, a software system for controlling said exchange as set forth in claim 4 in which said network protocol communications links include a user part and a message transfer part and the communications between said telecommunications control modules in the same exchange enabled by said transaction module include said message transfer part.

6. A software system for controlling a stored program controlled telecommunications exchange, comprising:

a plurality of application modules for providing telecommunications services to the users connected to said exchange, each application module including control instructions and data for the implementation of a specific telecommunications application for said users;

a plurality of resource modules for providing certain functional elements of telecommunications services to each of said application modules, each resource module having access to and control over the relevant hardware components of the exchange necessary for performing the specific functional actions required to implement its assigned service elements; and

means for providing communications between each of said application modules and each other application module and each resource module to enable the telecommunications services of each application module to be provided to said users without use of the control instructions or data of any other application module.

7. A software system for controlling a stored program controlled telecommunications exchange as set forth in claim 6 in which said means for providing communications between each of said application modules and each other application module include network protocols.

BNSDOCID: <WO 9300776A1>

8. A software system for controlling a stored program controlled telecommunications exchange as set forth in claim 6 in which said means for providing communications between each of said resource modules and each other resource module and each of said application modules include interfaces.

9. A software system for controlling a stored program controlled telecommunications exchange as set forth in claim 6 wherein said application modules include:

a service application module for providing said application specific telecommunications services; and

an access application module for connecting said users to said service application modules to receive said services.

10. A software system for controlling a stored program controlled telecommunications exchange as set forth in claim 6 wherein said resource modules include:

a transaction manager resource module for enabling communications between respective ones of said application modules; and

a connection manager resource module for controlling the hardware of the exchange in response to instructions from said application modules.

11. A software system for controlling a stored program controlled telecommunications exchange as set forth in claim 10 in which said means for providing communications between each of said application modules and each other application module include network protocols comprising a user part and a message transfer part and the communications between said application modules enabled by said transaction resource module includes said message transfer part.

12. A software system for controlling a stored program controlled telecommunications exchange as set forth in claim 6 wherein said communications providing means includes:

a plurality of network protocols for structuring the passage of messages between respective application modules so that each module communicates with every other module without any knowledge

of whether or not the module with which it is communicating is within the same exchange.

13. A method for structuring the software within a stored program controlled telecommunications switching exchange located and forming a node within a telecommunications network to provide service to a plurality of users having diverse communications applications among them, said method comprising:

storing within said exchange a plurality of software modules, each module containing the control instructions and data for providing communication services of a particular application type and each module acting as a node within said exchange in the same way the exchange acts as a node within the network to enable changes in network requirements to be mapped into corresponding changes within the software nodes of said exchange; and

providing communications between each of said nodes comprising each of said software modules within said exchange and each other node within the network.

14. A method for structuring the software within a stored program controlled telecommunications switching exchange located and forming a node within a telecommunications network as set forth in claim 13 in which said step of storing software modules within said exchange includes:

storing a plurality of resource modules, each resource module being capable of communicating with each of said software modules and having access to and control over the relevant hardware components of the exchange necessary for performing the specific functional actions required to implement assigned service elements.

BNSDOCID: <WO 9300776A1>

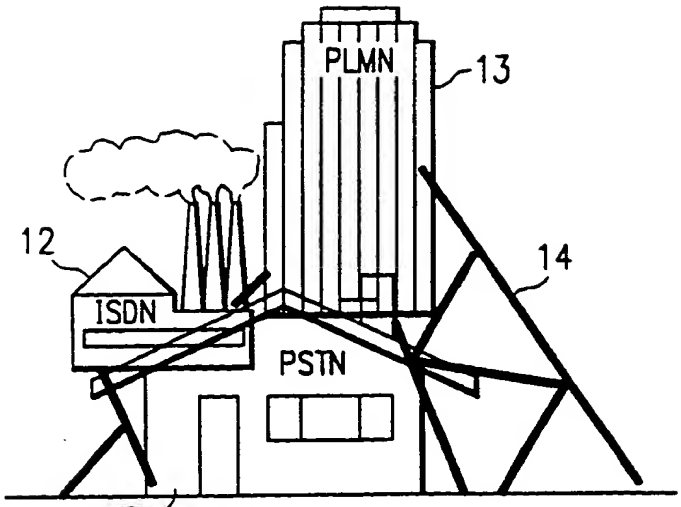


FIG. 2
(PRIOR ART)

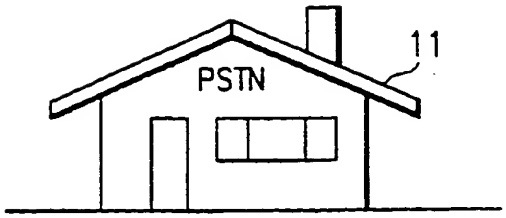


FIG. 1

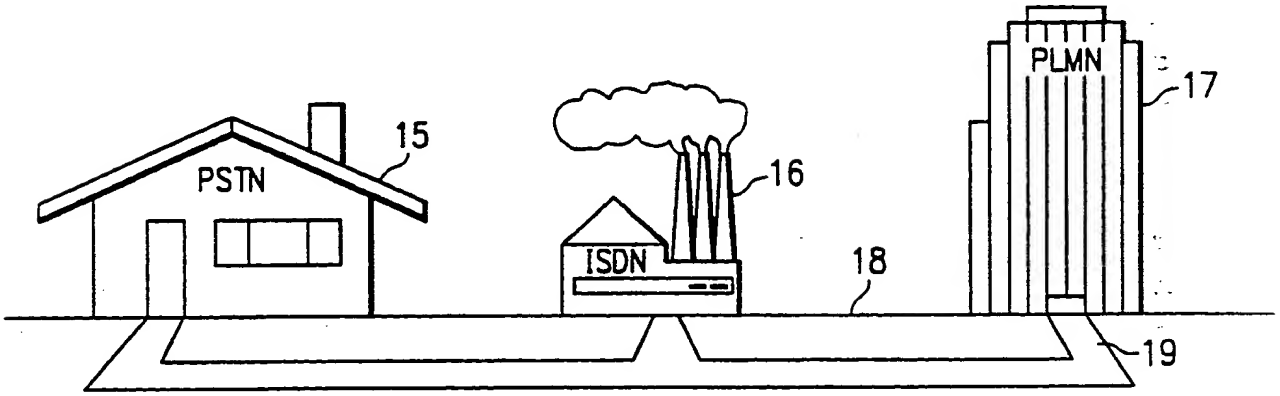


FIG. 3

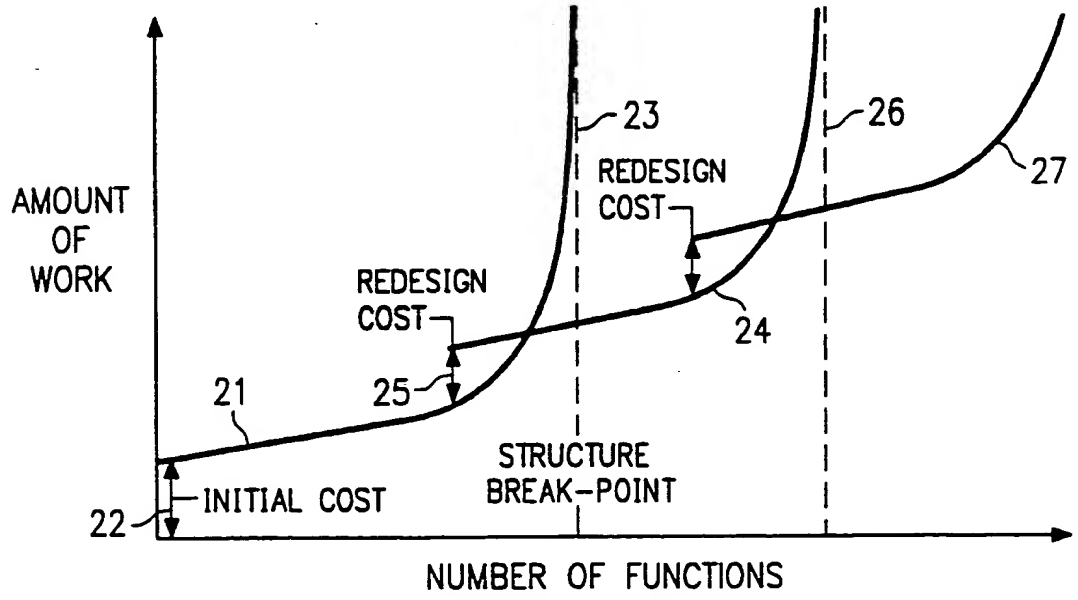


FIG. 4

BNSDOCID: <WO 9300776A1>

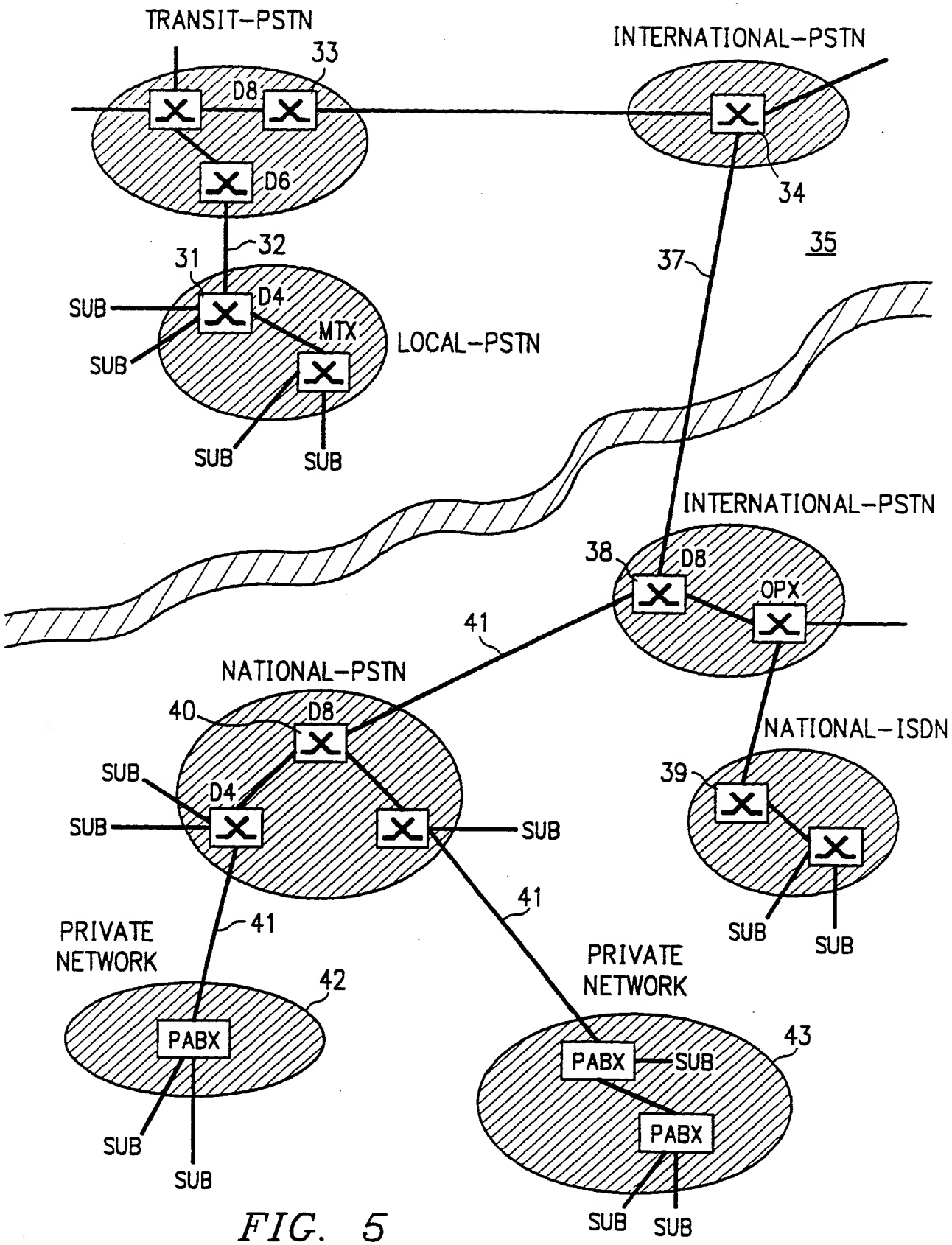
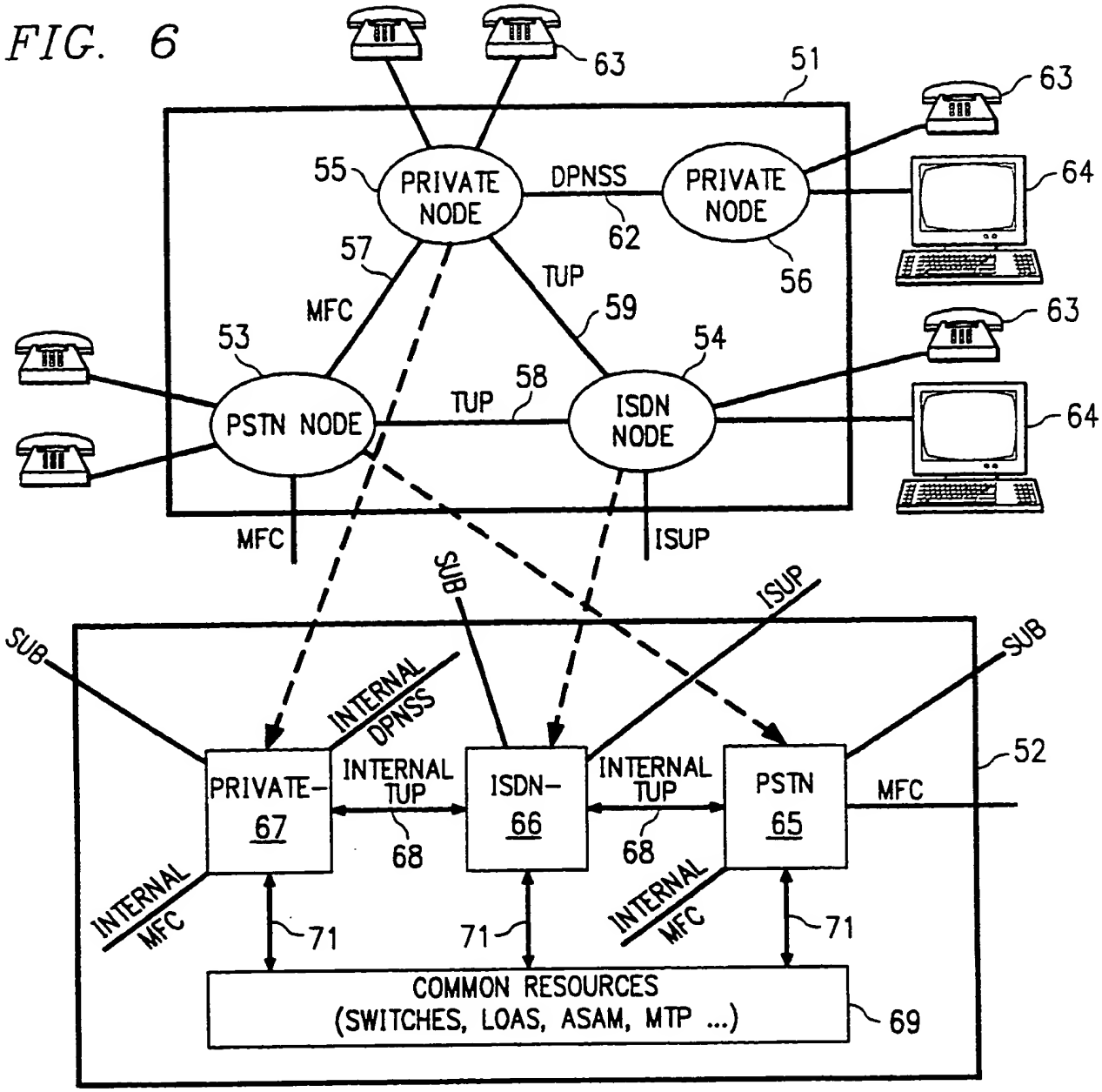

TRANSIT-PSTN
33
D8
D6
INTERNATIONAL-PSTN
34
35
37
31
32
SUB
D4
MTX
LOCAL-PSTN
SUB
SUB
SUB
INTERNATIONAL-PSTN
38
D8
OPX
41
NATIONAL-PSTN
40
D8
SUB
D4
SUB
SUB
NATIONAL-ISDN
39
SUB
SUB
41
41
PRIVATE NETWORK
42
PABX
SUB
SUB
PRIVATE NETWORK
43
PABX
SUB
PABX
SUB
SUB

FIG. 5

FIG. 6


63
51
63
55
PRIVATE NODE
DPNSS
PRIVATE NODE
64
62
57
56
TUP
MFC
59
63
53
54
58
TUP
PSTN NODE
ISDN NODE
64
MFC
ISUP
SUB
ISUP
SUB
SUB
INTERNAL DPNSS
PRIVATE- 67
INTERNAL TUP
ISDN- 66
INTERNAL TUP
PSTN 65
MFC
52
68
68
INTERNAL MFC
INTERNAL MFC
71
71
71
COMMON RESOURCES
(SWITCHES, LOAS, ASAM, MTP ...)
69

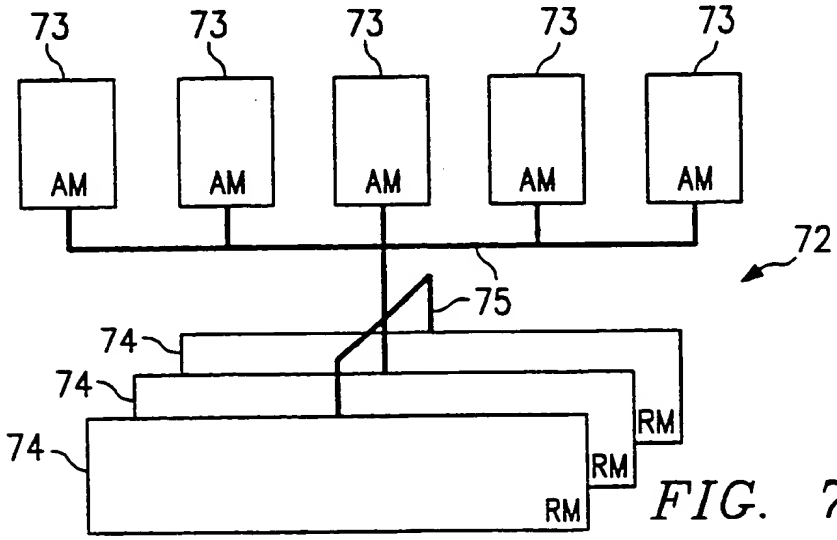

73
73
73
73
73
AM
AM
AM
AM
AM
72
75
74
74
74
RM
RM
RM

FIG. 7

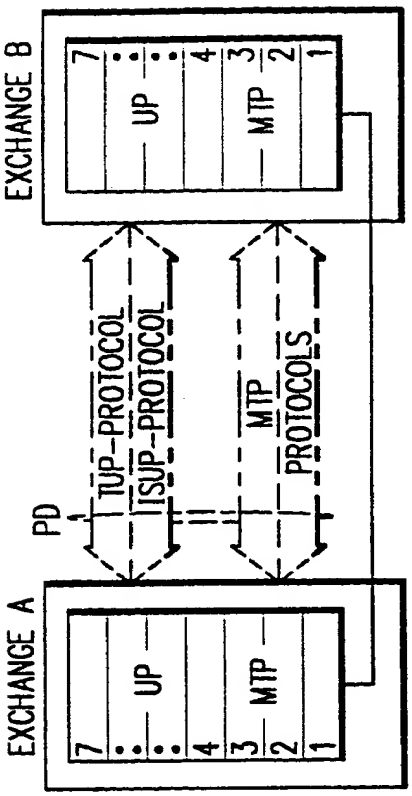


FIG. 9

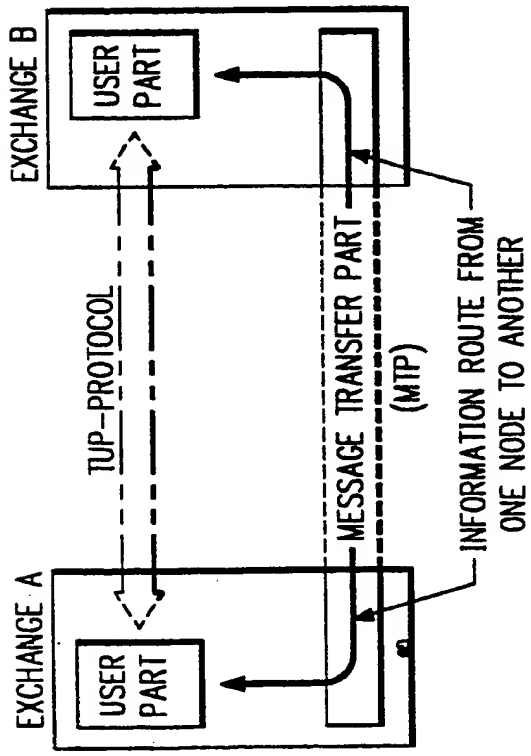


FIG. 8

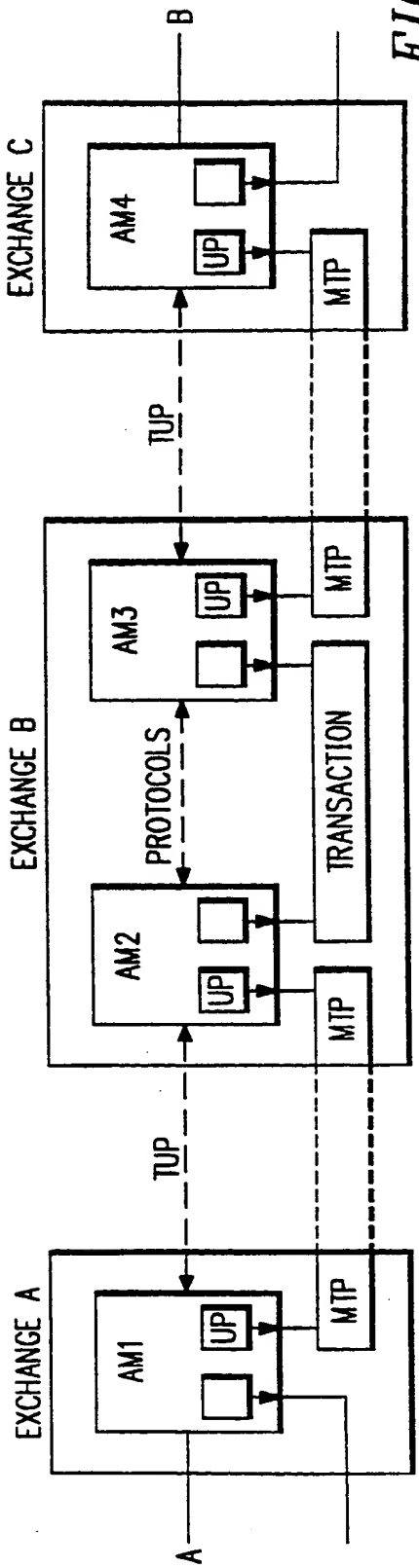
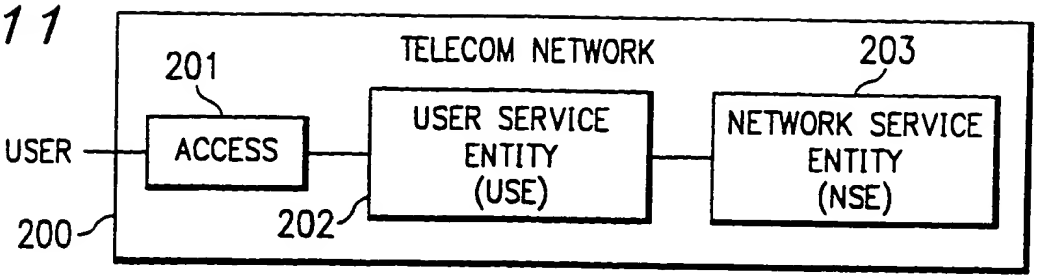


FIG. 10

BNSDOCID: <WO 9300776A1>

FIG. 11



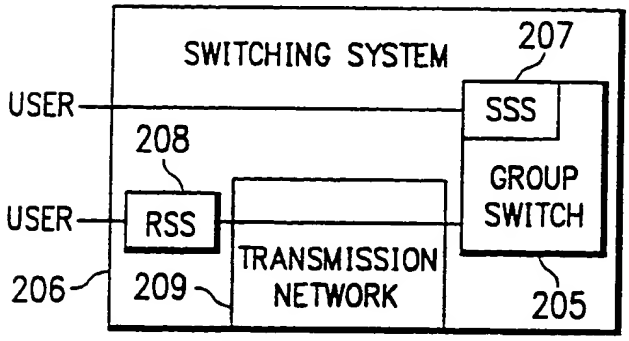


FIG. 13

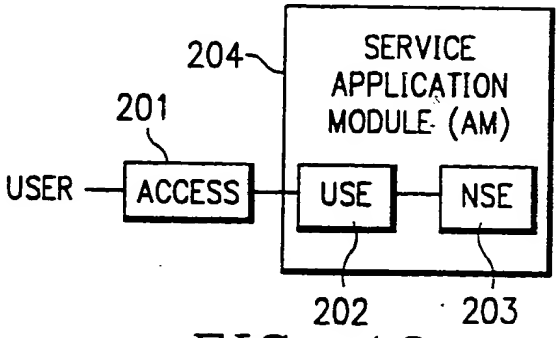


FIG. 12

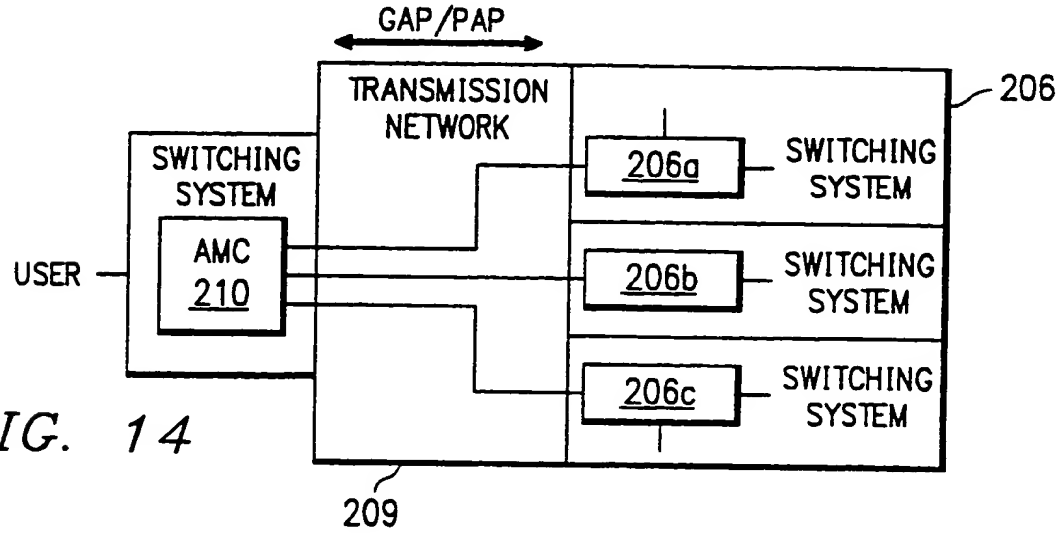


FIG. 14

BNSDOCID: <WO 9300776A1>

FIG. 15

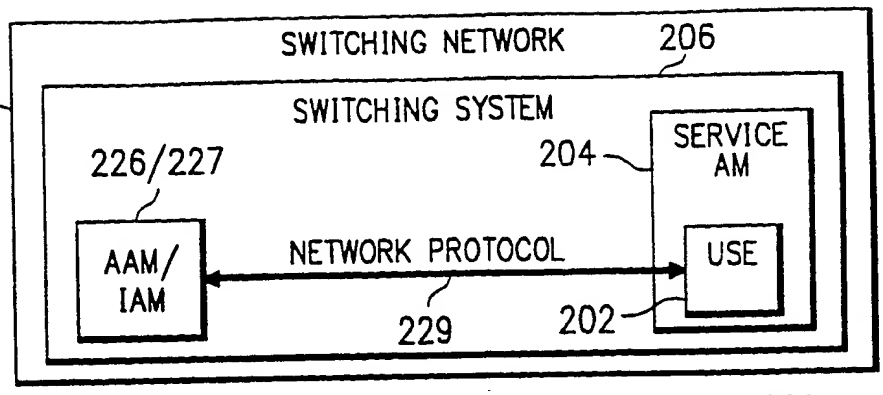


FIG. 16

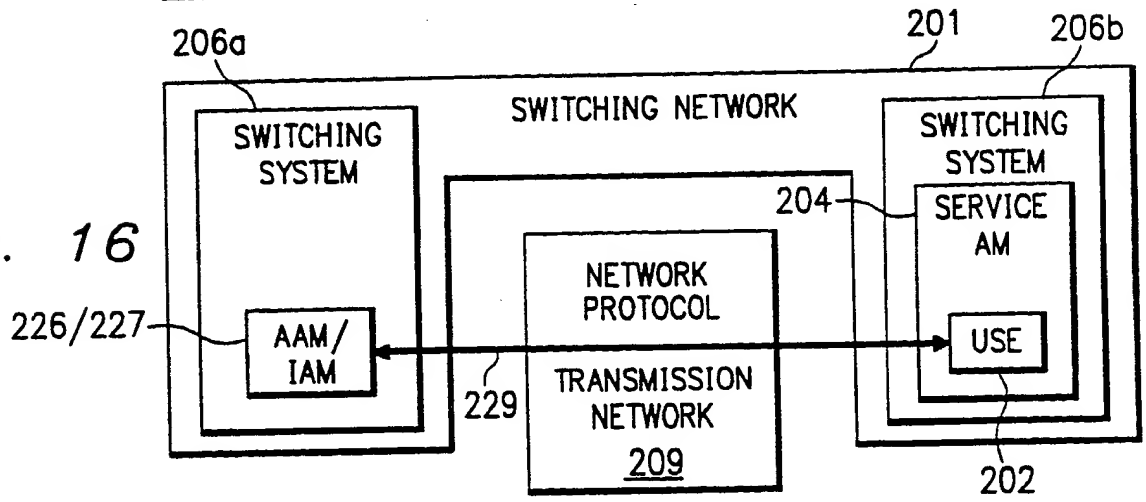
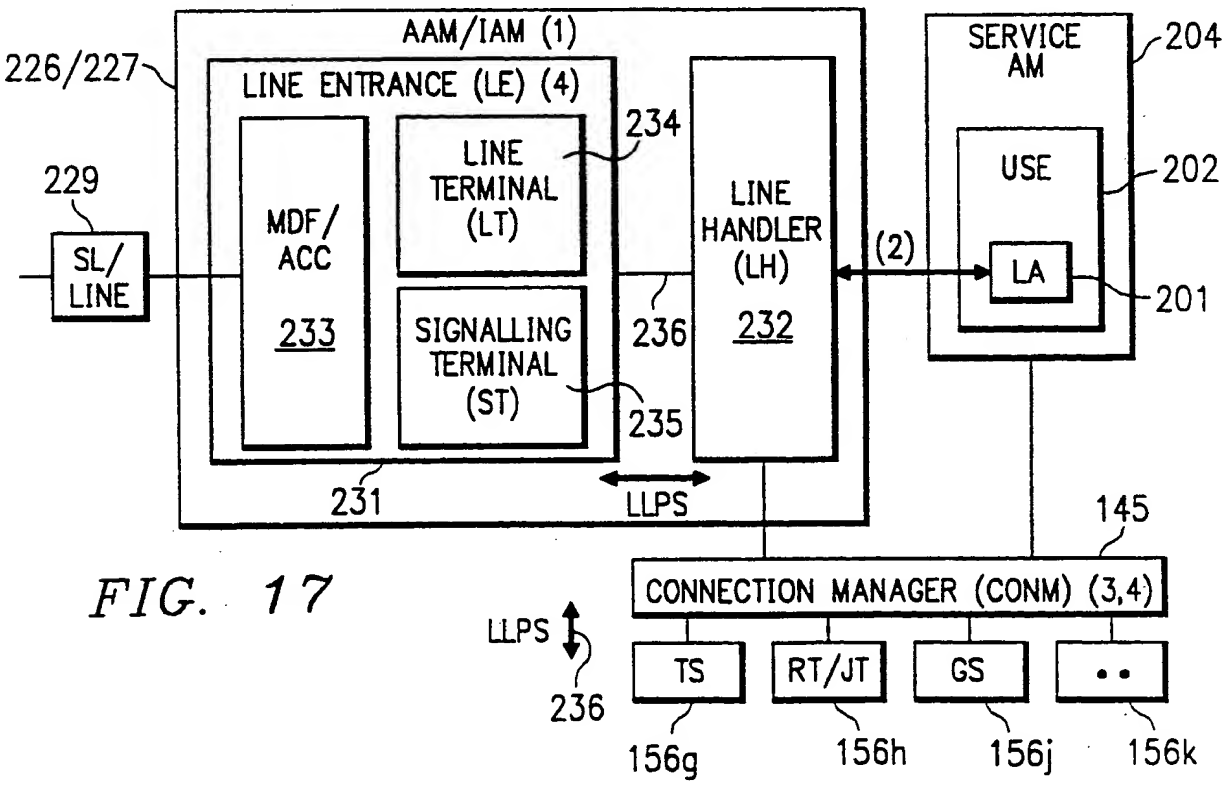


FIG. 17



BNSDOCID: <WO 9300776A1>

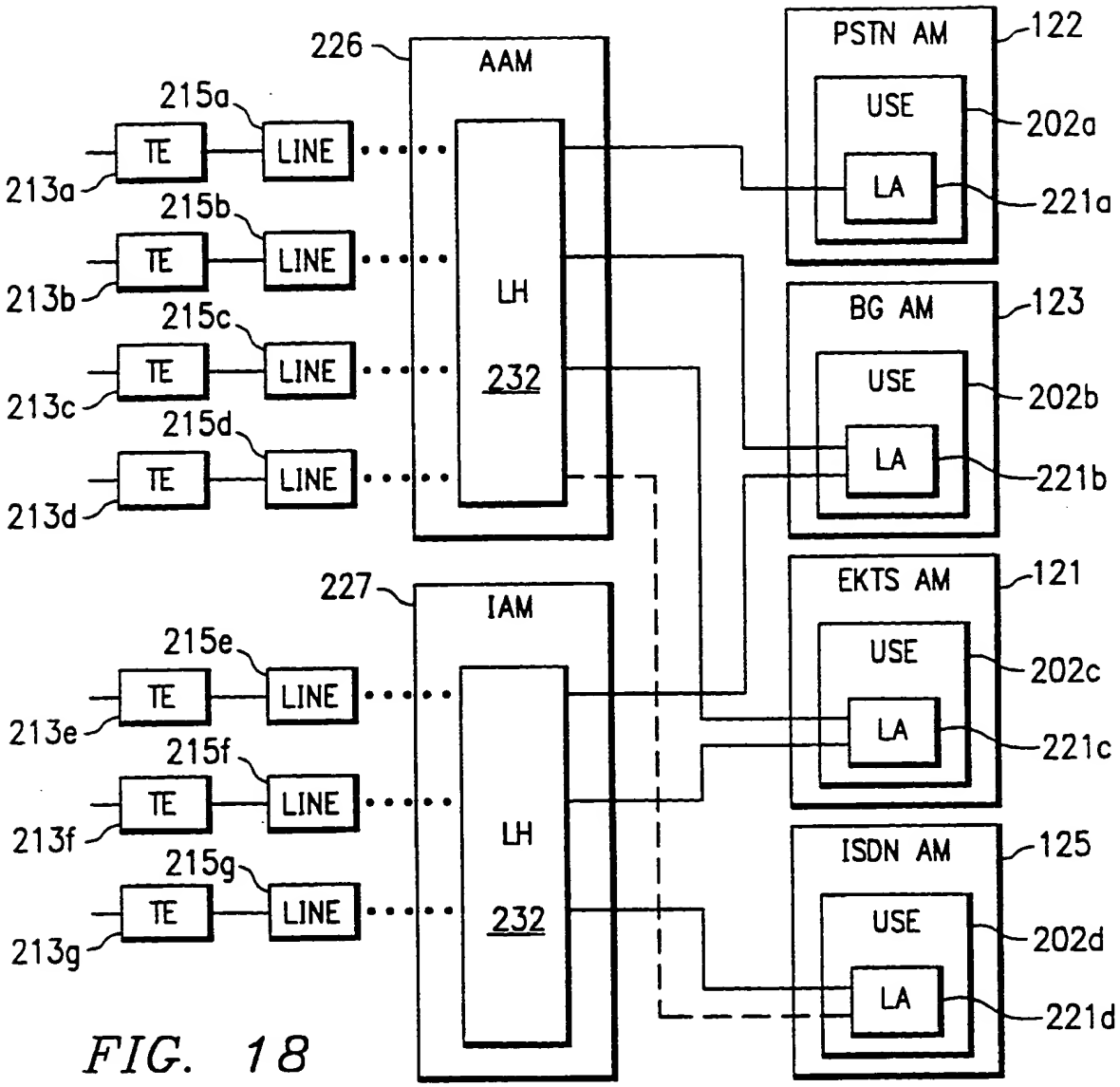


FIG. 18

BNSDOCID: <WO 9300776A1>

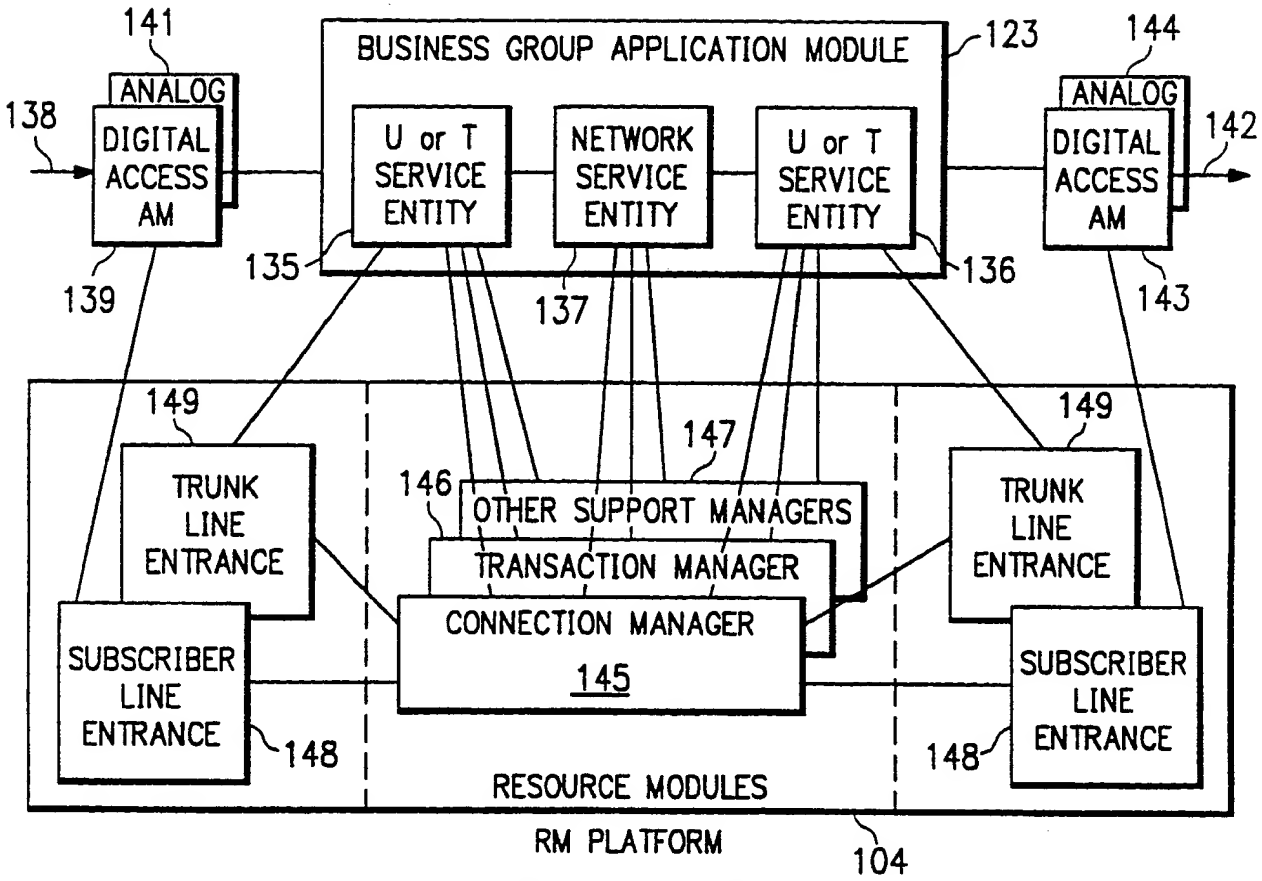


FIG. 19

BNSDOCID: <WO 9300776A1>

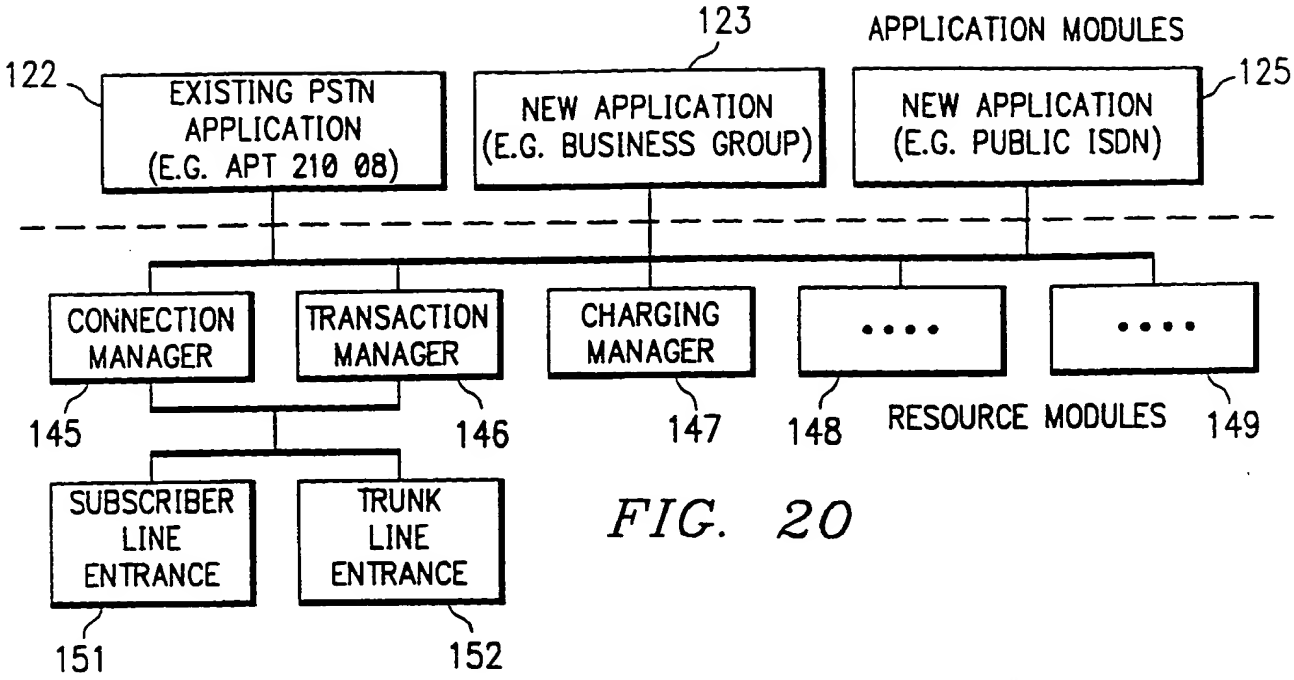


FIG. 20

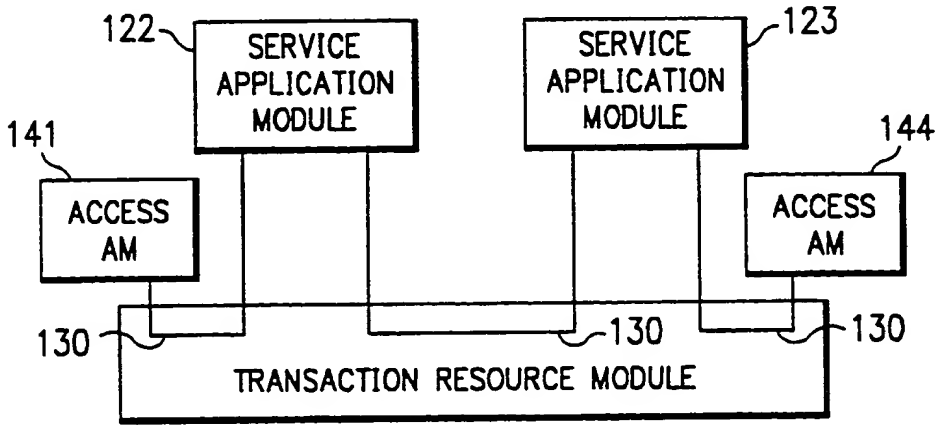


FIG. 21

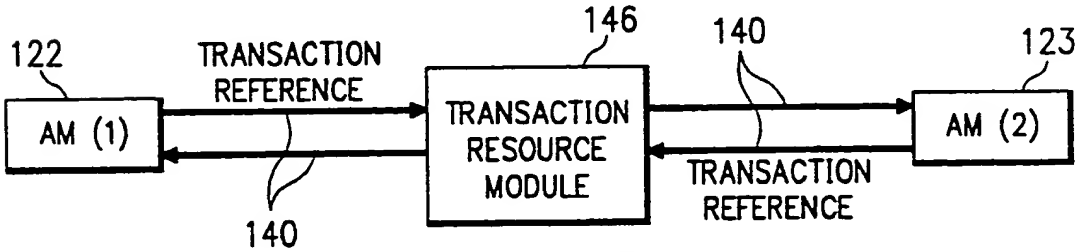


FIG. 22

BNSDOCID: <WO 9300776A1>

FIG. 23

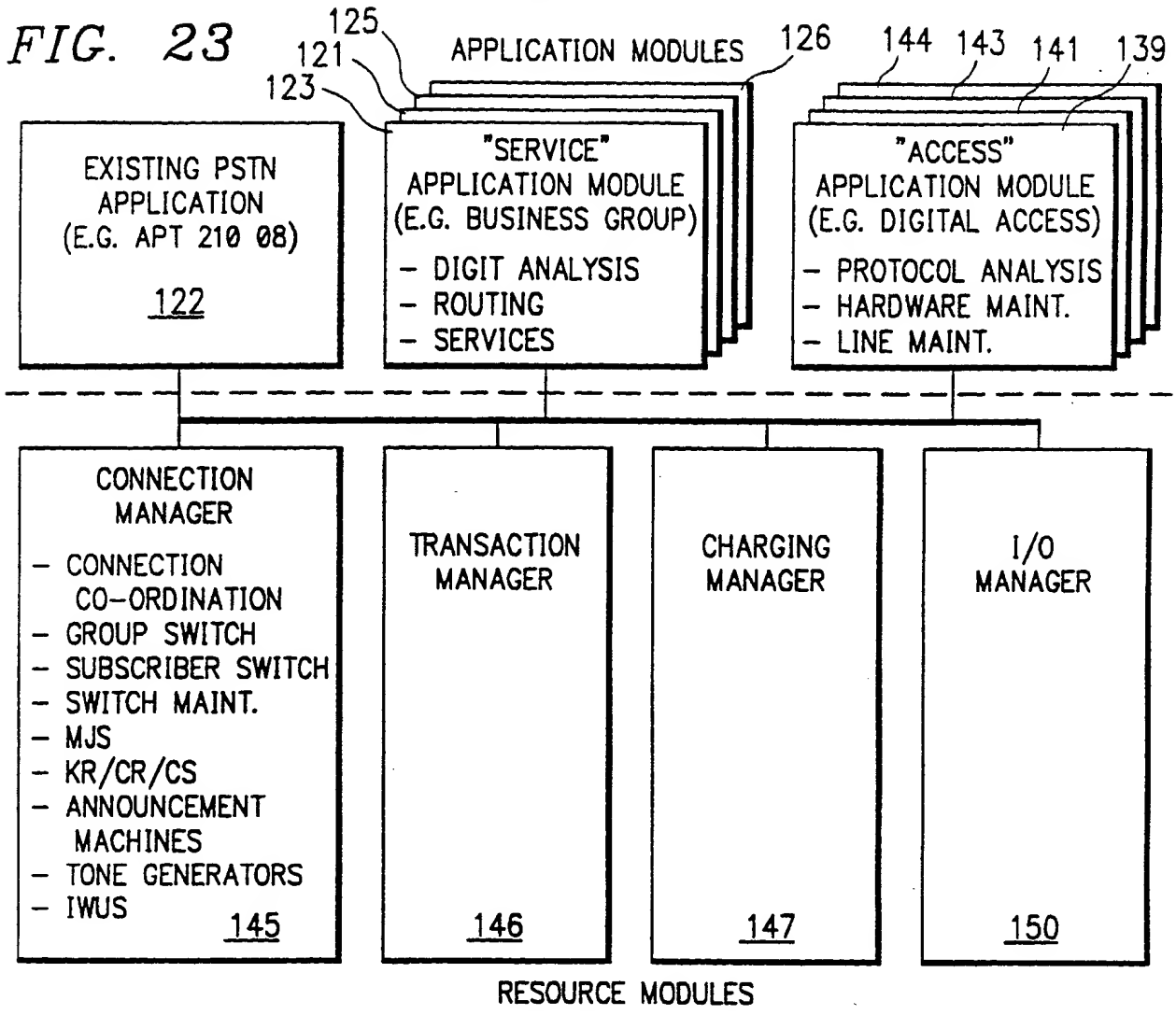
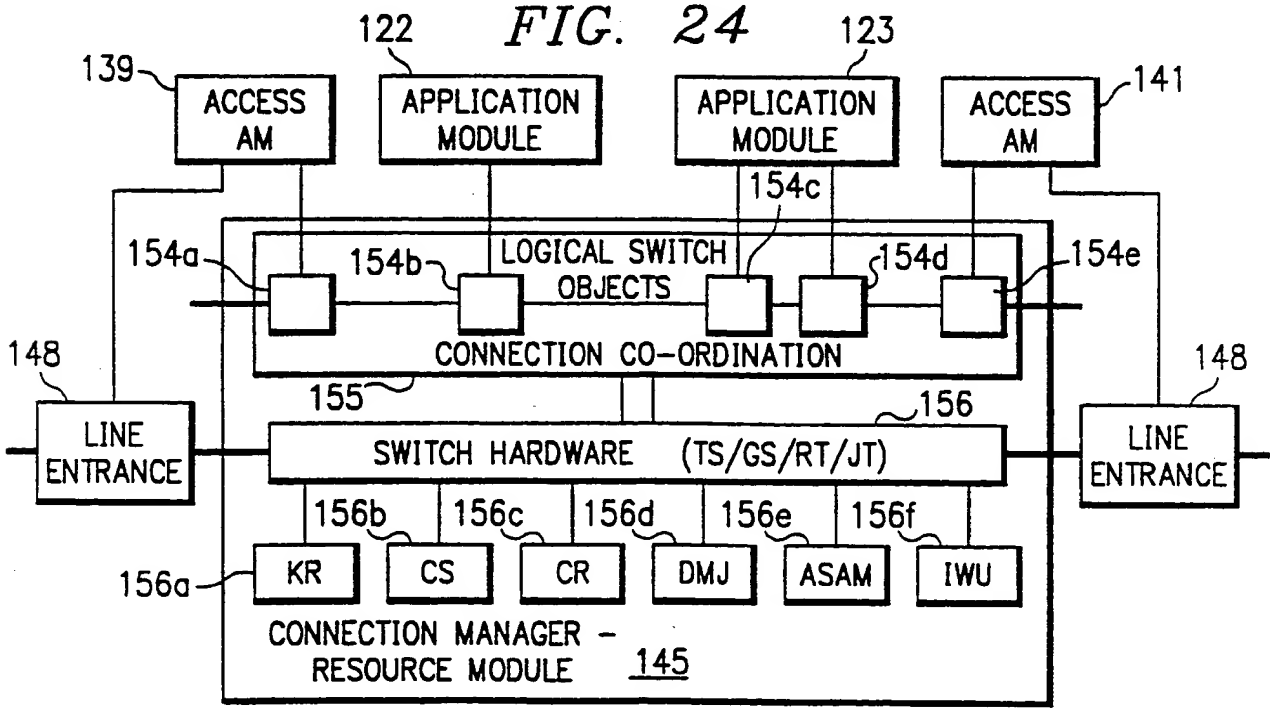


FIG. 24



BNSDOCID: <WO 9300776A1>

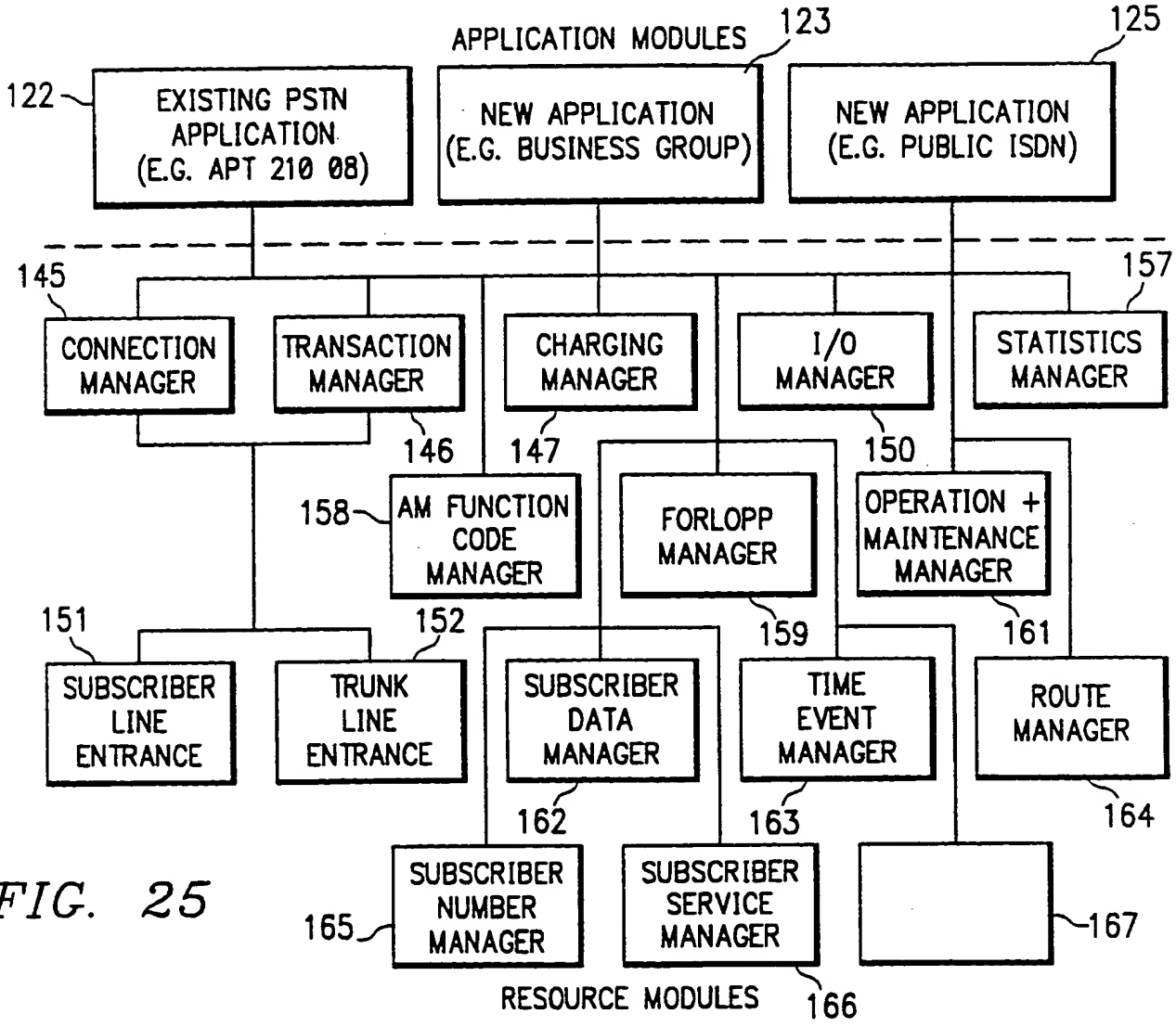

APPLICATION MODULES
123
125
122
EXISTING PSTN APPLICATION (E.G. APT 210 08)
NEW APPLICATION (E.G. BUSINESS GROUP)
NEW APPLICATION (E.G. PUBLIC ISDN)
145
157
CONNECTION MANAGER
TRANSACTION MANAGER
CHARGING MANAGER
I/O MANAGER
STATISTICS MANAGER
146
147
150
158
AM FUNCTION CODE MANAGER
FORLOPP MANAGER
OPERATION + MAINTENANCE MANAGER
151
152
159
161
SUBSCRIBER LINE ENTRANCE
TRUNK LINE ENTRANCE
SUBSCRIBER DATA MANAGER
TIME EVENT MANAGER
ROUTE MANAGER
162
163
164
165
SUBSCRIBER NUMBER MANAGER
SUBSCRIBER SERVICE MANAGER
167
RESOURCE MODULES
166

FIG. 25

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00429

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: H 04 Q 3/545 // H 04 Q 11/04

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	H 04 Q

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	US, A, 4686701 (AHMAD ET AL) 11 August 1987, see abstract; claims 1-25 --	1,6, 13
A	US, A, 4683584 (CHANG ET AL) 28 July 1987, see abstract; claims 1-21 --	1,6, 13
A	US, A, 4694487 (CHANG ET AL) 15 September 1987, see abstract; claims 1-21 --	1,6, 13
A	US, A, 4689815 (GREWAL ET AL) 25 August 1987, see abstract; claims 1-21 --	1,6, 13
A	US, A, 4720854 (SAND) 19 January 1988, see abstract; claims 1-20 --	1,6, 13

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
13th October 1992	14 -10- 1992
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Sven-Olof Wirlée

Form PCT/ISA/210 (second sheet) (January 1985)

BNSDOCID: <WO 9300776A1>

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
P	US, A, 5119366 (ARDON ET AL) 2 June 1992, see abstract; claims 1-23 --	1,6, 13

BNSDOCID: <WO 9300776A1>

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 92/00429

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 30/09/92
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4686701	87-08-11	CA-A- 1243386	88-10-18
		EP-A-B- 0214179	87-03-18
		JP-T- 62501742	87-07-09
		WO-A- 86/04740	86-08-14
US-A- 4683584	87-07-28	CA-A- 1250937	89-03-07
		EP-A-B- 0216799	87-04-08
		JP-T- 62501949	87-07-30
		WO-A- 86/04764	86-08-14
US-A- 4694487	87-09-15	CA-A- 1250938	89-03-07
		EP-A-B- 0214178	87-03-18
		JP-T- 62501740	87-07-09
		WO-A- 86/04763	86-08-14
US-A- 4689815	87-08-25	AU-B- 584452	89-05-25
		AU-D- 6165586	87-02-26
		CA-A- 1253600	89-05-02
		EP-A- 0214499	87-03-18
		JP-A- 62181596	87-08-08
US-A- 4720854	88-01-19	CA-A- 1260590	89-09-26
		EP-A- 0228204	87-07-08
		JP-A- 62188590	87-08-18
US-A- 5119366	92-06-02	EP-A- 0491491	92-06-24

BNSDOCID: <WO 9300776A1>

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

This Page Blank (uspto)